



THE  
GUNNER  
SHEWING THE  
VVHOLE PRACTISE  
OF ARTILLERIE:

With all the Appurtenances there-  
unto belonging.

Together with the making of Extra-  
ordinary Artificiall Fireworkes, as well  
for Pleasure and Triumphes, as for  
Warre and Service.

Written by ROBERT NORTON, one of his  
Maiesties Gunners and Enginiers.

LONDON,  
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to be sold at the three Pidgeons in Pauls-  
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J. FRANCK. 144  
1667



DAVID.

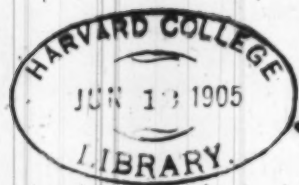


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TO  
THE EMPERIAL  
MAIESTIE OF GREAT  
BRITTAINE, FRANCE,  
AND IRELAND,  
KING CHARLES.



Almighty God hauing made your *Maiesty* Soueraigne ouer many strong Nations, naturally Martiall, and Artificially exercised in Armes: Yet if they want Discipline (though many) they are but few; and though else strong, yet therefore weake. Your mighty Kingdomes also being strongly situated by Nature, Intrenched about with a broad Dike the Seas, Pallisadoed with Rockes and Sands, Sentinelled with strange setting Tydes of Ebbes and Floods, Defended by frequent Stormes and Tempests, highly Inriched with Fertillity of Nature, Furnished plentifully with all manner of Materialls fitting the felicity of Mans life vpon Earth, both for time of *Peace* and *Warre*; So that nothing can seeme to bee more wished for, if Industry bee vsed; but especially, if Correspondency bee found in a good and due temper betweene the Head and the Members, as perfect Obedience and Seruice from the Members to the Head, and entire loue and care from the Head to the Members, for their good and safety. *Gunnes* your *Maiesty* hath, but want *Gunners*, because they want Respect and Encouragement: let

## THE EPISTLE DEDICATORIE.

Occasions be ruled with Reason, VVarrs managed with Discipline, Iudgement, and Pollicie: Let stubborn Offendors be punished, Deseruing Men preferred, Eminent Places not granted for Fauiour to insufficient Men or Strangers; hauing honest Subiects farre more able to performe the Seruice: So we shall all make Holiday to serue our *God*, obey our *King*, and enioy Gods bleatings bestowed vpon vs, *euery Man Eating his Grapes vnder his owne Vine*, without feare of forraigne Enemies: To conclude then, nothing can be wanting, Men, Money, Meanes nor Prosperity; when the God of Order hath settled such a congruity. Now that your Maiesty may the better be prouided hereafter of vnderstanding *Gunnners* to manage your Artillery, the powerfull Regent of moderne VVarre: I haue endeouored in this *Practice of Artillery*, to supply their wants the best I can, not doubting but in short time it may worke good effect therein: If your Maiesty will be gratiouly pleased to countenance these few Lines vnder your Royall Patronage. My wrongs and discouragements hath hitherto hindred the publication hereof: VVhich, if your Maiestie would be pleased to referre to be examined and relieved accordingly; It will then appeare I had cause to speake; And I should be againe encouraged for greater and further Seruices hereafter: So most humbly crauing pardon for my boldnesse, prostrating my selfe at your Sacred Feete, as by Oath and Duty bound, will euer remaine,

*Your most Faithfull and Loyall*

*Subiect and Seruant,*

ROBERT NORTON.



To Mr. Robert Norton, and his Practise of Artillery.

**V**hen first I knew the difference of Time,  
and severall *Climates* of the Worlds round Globe,  
I then thought *Artists* fittest Men to clime  
to Honor, and to weare the Golden Roabe;  
But now these Times doe differ from that Time,  
Strangers respected are By Courtiers crime.

Then when I knew the Seas, my whole delight  
was how to trimme a Shippe prepar'd for Warre;  
But all was vaine, till *Gunnners* Skill and Might,  
with practiz'd Forces all excells so farre;  
Let *Sea-men*, *Land-men*, all *Mentru*ly know  
Thas *Gunnners* Art's of Substance, not of Show.

The *Land-man*, he most boldly makes Approch  
with Horse and Foote, with Sword, and Shield, and Speare,  
But all were vayne, he neuer could encroach,  
if *Gunnnes* and *Gunnners* should be wanting there;  
Therefore such Artists sure t'were best to cherish,  
And expert *Gunnered Engineers* to nourish.

For prooffe whereof, let euery Artist view,  
why such Men should not to preferment mount,  
Peruse this Booke, its Lynes, and Figures true,  
so may he finde the difference of Account  
Twixt th' *English*, and the *Dutch*, *Norton*, and *Borre*,  
Then giue our owne their due without demor.

Moratur in  
lege.

But Norton, I haue been something to bold  
to Paraphrase vpon thy Worth and Quality,  
Because I want sufficient, to vnfold  
them, and th' *Ingenious* Workes reality;  
Let this suffice, thy praise will shew it selfe,  
It's worth the *Golden-Flacce*, the *Indian Pelfe*.

Captaine Iohn Butler.

A Due to the Author, his Worke and Worth.

Since amongst all Nations Warre it selfe doth shewe,  
It behooues Man Warres Weapons for to know,  
Who here may learne the Gunners ayming Arts,  
Which thy free industry to all imparts;  
The fittest subiect now it is by farre,  
At these times, when such Rumors are of Warre,  
And fillles the Eares, and Courages awake,  
Goe on then, and to Thee this glory take,  
That be that reads these things which thou dost write,  
May know a Gunners part, though he nere fight,  
And know Warres chiefe Engines use and strength,  
In Bore, Cilinder, Axis, and in Length,  
In Touch-hole, Carriage, Wadd, in Shot and Charge,  
Of Fire-workes in brieft thou speakest at large;  
French, Spanish, Dutch, Italian, vaile your Cappes  
To Nortons skill, in Mars his Thunder-claps.

Iohn Rudstone a Lover of the  
*Artes Mathematicall*, The-  
orick and Practick.

---

To his good Friend Master *Robert*  
*Norton*, on his *Practise of Artillery*.

**I** Told you Friend, before your Booke I'de write,  
But not Idolatrize with Poetick spright,  
Doing our loues much wrong, in little right.  
The Times necessity, and each Studious minde  
Will make it prayse it selfe, which you shall finde  
By'ts oft impression, th'Art being here refinde.  
Yet (iustly I confesse) I haue been showne  
Bookes that sell well, yet not for what's their owne,  
But for Commendators before them knowne.  
And this integrity Commands me say,  
That to the Truth thou shewst the rightest way,  
For Young Artists, and here the Old may stay.  
For here th'are satisfied with small dispencc  
Of Purse, or Braines, of Skill the quintessence,  
Drawne from the Antick Artists excellence.  
I know rich Jewells may themselues commend,  
Which be such Bookes (that for the publique end)  
With Iudgement written are, So thine good Friend.

*Richard Robinson.*

---

In the due Honor of the Author Master  
*Robert Norton*, and his Worke.

**P**erfection, if't hath euer been attained,  
In Gunners Art, this Author hath it gayned,  
By Study and Experiences, and he  
The Fruite of all his Paynes hath offered Thee,  
A Present well besitting this our Age,  
When all the World is but a Marttall Stage:  
Let sweeter Studies lull a sleepe and please  
Men, who presume security, but these  
Thy Labors practiz'd, shall more safely guard  
Those that foresee the Danger, th'other bar'd  
This benefite: Wee Soldiers doe embrace  
This Rare and usefull Worke, and o're the face  
Of all the World, let thy Fames Echo sound,  
More then that roaring Engin, and redound  
To th' Honor of our Nation, that thy Paynes  
Transcends all former, and their glory staines.

Captaine John Smith,

HUNGARIENSIS.

A

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I hope



## THE PREFACE TO THE courteous Readers.

**T**He Art and Practise of Artillery (the subiect of this present Treatise) being as Bianco saith, the Crowne and Palme of the Warres and Military discipline, teaching how to ouerthrow & demollish Citties, Towns and Castles, to sinke Shippes, and inhumanely euen to teare the life and soules from the bodies of innocent men, women, and children, viet armis, to get the possession of the Goods and Lands that rightly belong to others for our selues: it may therefore at the first blush seeme to be absolutely contrary to all Christian charity. But when on the contrary wee come to finde, that Warre is euen the Mother and Nurse of Peace, the Rampart of Iustice, and the Law of the World; yea, the Scriptures affirme that War was a thing authorized by God himselfe, who commanded Saul thereby to destroy the Amalekites, and not to spare either Man or Beasts, &c. As also that Warre was exercised in Heauen by the good Angels against the bad: So likewise hath Nature armed the Beasts of the Field, the Fowles of the Ayre, and the Fishes of the Sea, and as it were by instinct, taught them with their Hornes, Tallents, Teeth, and Finnes, to fight one with another, to defend themselves, and offend others. But more especially, when wee truly consider, how that without Warre and Warlike Amonition, and Discipline, no Kingdome or Common-weale can long subsist in Peace, or be able to defend it selfe, nor offend their Enemies: the case will then seeme to be much altered. These then, and the great preparations, the Martiall pollicies, cruell stratagems, and deuillish inuentions of the common Enemies of our King and Country (whereby they intend, and with malicious greedinesse daylie endeouour to destroy vs all with our Wines, Children, and Families, to the end to possesse our goods and lands.) These I say may more then incite vs now (though late) to learne, know, and vse to practise this principall and potent part of Warre, so that thereby with Gods assistance (alwayes making him on our

B

side)



## The Epistle

side) we may become able and prosperous in resisting those their intended mischiefs, and breake the necks of their cursed designs, and so consequently escape those eminent and threatened dangers.

Now for as much as the most prosperous effects haue vsually succeeded and most vigorously prevailed, when ingenious inventions and religious politike diligences hath beene ioyned with Armes (good Pollicie farre exceeding Force.) Therefore for the better vnderstanding of the sequent discourses, we shall doe well first to conceiue that euery materiall thing is either to be lineally described, or else intellectuall vnderstood by some proper Figure, or apt word, name, or definition, which properly belongeth thereunto: For as euery Art hath certaine Rules and Principles (to preceade) without the knowledge of which no man can attaine vnto a necessarie perfection for practise thereof, vnlesse hee first endeouour to learne (rather by Reason then by Roate) what each part thereof is, with the Name and Nature of each Member and part of it (without which first obtained) And I say, let a man take neuer so much paines and studie therein, he shall but in vaine puffle his braines and not benefitting himselfe. The neglect of which is the cause why many (otherwise well affected to Art) doe so fruitlesly bestowe both their Time, Labour, and Cost, to no purpose, often condemning the Art as too hard for them, when (God knowes) the onely cause is their disorderly progresse in the studie and practise thereof: And I dare say for the Gunners Art, although it be deepe (euen able to spose the knowne parts of Naturall Philosophy, Arithmetick, Geometry, and Perspective, each of which her handmayd is) yet by the Definitions, Theorems, and Questions contained in my former Booke extant, Of the Art of great Artillery, and in this of the Practise of Artillery, I hope the willing may (with small paines ioyned with orderly and diligent practise) wade ouer this Ocean safely satisfied; neuerthelesse that if Archimides (were he now liuing) without experience and long practise therein) with sundry tryals he could not possibly demonstrate the manifold varieties of that Mixthellicall arch or circuit of the Bullets courses, compounded of violent and naturall motions, and receiuing infinite diuersities, according to the seuerall proportions and temperatures of the Powder, length of the Peece, matter of the Shot, Mounture, and Metall, lead on by Experience the Mistress of all Arts, Action being the best Tutor: Much lesse I (the most unable of many) who haue endeououred herein more to respect a few experimented truthes, then many Rhetoricall imbellishments of words. Therefore neither can, or will, I presume to assume



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## To the Readers.

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assume so exact perfection to bee herein: although I haue endeouored to auoyde the apparant errors of Santbech, the erronious principles of Tartaglia the false rules of Rosselli, the time-ouerworne directions of Cataneo, the grosse allowances of Collado for Mountures & Imbasings, but especially the arch false proportionality taught in Mr. Smiths Art of Gunnery, now entituled the Complete Souldier (many of which are by Mr. Diggs and my selfe noted, at the end of my said Booke of the Art of great Artillery, and a number more there are most intollerable false, For the positions which hee there incerteth, are fit onely to leade young Gunners out of the right path and way they should walke in, with a seeming easinesse by tying (as he would) such things to Arithmeticall works and proportions, as are directly contrary, and of another nature, as a small tryall will manifest, which in crutesie, I thought fit to aduertise the Reader of: But as Palingenius saith,

Friuola si fuerint fundamina tempore paruo  
Deficiet, quicquid super his fabricare volumus.

Some men also may imagine because the figures beerein are many of them, the same that were cut for Captaine Vffanoes Booke of Artillery, Printed at Frankford, that therefore I haue onely translated the same. I confesse the figures most of them being good, and he for this and the most part he hath written of this practise, being the best of any the Authors that I euer read: yet had I onely translated him, I should but little haue helped English Gunners: their Measures, Waights, Ordnance, and Powder so much differing from our English, as in their places I haue shewed, it would not haue been opera pretium so to haue done: But that I haue from him and other Authors made chose of some things, and refined & applied others for our benefits, I am not to denie; nor that the Figures are many of them his that I haue herein written vpon, which was by reason of their goodnes, faireness, and cheapenes; for the Figures, had they beene cut of purpose in England, would haue made these Bookes too deare for Gunners, for whose good they were originally destined, wherein I haue roughly endeouored in well meaning, which if it be well taken, I shall be therewith well satisfied, and rest readie to explaine whatsoeuer shall beerein seeme difficult.

Now that this my Treatise for the practise of Artillery, may the more currantly proceede, & be the playner to the vnderstanding and satisfaction of the Reader, I held it necessarie first to shew by certaine Definitions, Demands, Axioms, & Theoremes (besides those in my former Book) called the Art of great Artillery (which I wish euery young Gunner to

## The Epistle

peruse also with diligence) the names, natures, and operations of such things as are necessarie to be knowne, used, and done in the Practick part thereof, without which it were impossible to conclude any thing well, and as it ought to be. Therefore as in the Warres of our age, there is no earthly force that can more command the Fortified, or resist the assaulting Enemy then great Ordnance duly used. So the Gunners therefore ought to endenour to understand these so well, that they discharge them not in vaine. First, in regard of the great expences of Ammunition thereby cast away: Secondly, least thereby they frustrate the wished service. Thirdly, in laying themselves and their Companies open and vndefenced to the Enemies Forces, which will (in them) encrease valour, and in your selves terrour, thereby also deseruing to purchase great blame and dishonour from the hands of their Commanders, with the losse of the Princes fauour, and vtter ouerthrow of their owne preferment euer after. Wherefore seeing that such fruitless discharging of Ordnance in the time of service, is so great an inconuenience, and happeneth most commonly for want of knowledge, or ready meanes to direct the Peeces precisely to the marke; I haue thought it worthy my labour therein to shew Artificiall meanes (to such as are desirous to learne) how to know, direct, and prepare the Peeces committed to their charge; so, that in time of neede they may bee assured to make their Shotts take good effect, onely by applying themselves to vnderstand and practise these fewe things following.

THE



# THE PRACTICE OF ARTILLERIE.

## The first Definition.



**P**LACE is the space enuironed with the interior superficies which containeth and enuellopeth each thing, limited in every sence with the proper dimensions of the thing contained.

Euclid. def. 9.  
lib. 1.

*As the Place of my Body hath the same dimensions that my Body hath.*

## Definition 2.

**Emptie**, is the Place in which no corporall thing is contained.

*But nature abhorring Emptinesse hath left no place for it in this sublinar world.*

Arist. lib. 4.  
tex. 57.

## Definition 3.

**Rare**, Is that which vnder large dimensions hath but little matter.

*Contrariwise Thicke or Grosse hath vnder little measure much matter for Thickenesse and Thinnesse are such bodies consequent qualities, as haue much or little matter vnder their dimensions.*

D. Tho. 1. 2. am.  
qua. 77.

## Definition 4.

**To Increase**, is to enlarge the former dimensions.

*Increasing commeth of changing of quantity from little to more which may bee without changing the figure, As the Gnomon added to the Square increaseth it, yet the figure remaineth square still.*

## Definition 5.

**To touch**, is to haue their extreames together.

*As touching is proper onely to a Body, saie it also proper vnto all Bodies, for it is reciprocally with the quantity of a Body.*

Arist. 2. 2.  
Phis. sent. 33.

## Definition 6.

**To Move**, is to transport from one place to another, or to turne into the same, or change the quality.

B

Because



Cap. 7. lib. 3.  
Phil.

Because that which we intreate of is Materiall, and depends upon an Action of Nature, we will define changing of Place to be made by mutation from the Place, or from the Grandure: as that which rarifieth, extendeth, and changeth place by increasing more, and one thing may mooue another by remoouing it, or by drining it away.

Definition 7.

To remooue, is to thrust out of the Place without expulsion or drining it away.

Arist. lib. 7.  
Phys. lib. 10.

So to carry, to lead, to put from, to presse downe, to draw, and such like moouing of things in that manner said to be remooued without being drinen, cast, or shot away.

Definition 8.

To Expell is to Remooue by drining out, darting, or shooting away, which is either slowly and easily, or swiftly and rudely.

Idem.]

Either as the Ramme Engine doth slowly, or as the Cannon doth swiftly drine away.

Definition 9.

Swiftnesse, is a force that doth much in a little time.

In Lache.

As any thing that is transported a long distance in a little space of time, is said to be swift.

Definition 10.

To Mount, is to raise or eleuate vpwards towards the Skie about the Horizon: To Embase is to descend, or depresse vnder the same, downwards, from the Heauens ward.

Those are termes depending upon the disposition of Men.

Definition 11.

Vnder the name of Artillery we comprehend all Armes of Fire.

As Gunns and Fireworkes, &c. for Warlike seruices.

Demand 1.

THAT the Superficies of the Columne of the Peece bee perfectly round, or else regularly squared, especially at the thickest of the Mettall at the Moutb and Breech.

Demand 2.

That the Axis of the Bore or Cavity (of the Peece giuen) be straight from the one to the other end of the Columne, and equidistant and paralell from the concaue Circumference thereof, at all places so farre as the Shot descendeth into the same, being of equall widenesse.

Demand 3.

That the Peece giuen to be prepared haue her ordinary Cariage and Platforme giuen, so right and duly fitted, as will neither cause nor suffer the Peece

Peece deliuering and reuerſing to ſtart from the leuell or direction giuen.

*Demand 4.*

That the Shot keepe his courſe ſo from his due reſting place in the cavi- ty of the Peece vnto the *Point Blanke*, or end of the right range thereof, ſo as that the centre of it be alwayes in the Axis of the Bore (ſuppoſed infi- nitely to proceede) without any ſenſible declination from the ſame. The ſaid Bore being part of the way of the ſaid ſhot, and the director of there- ſide of the courſe of the ſame.

*Demand 5.*

That the *Point Blanke*, or right line or Range be that point in the Axis of the Bore imagined to proceed and bee infinitely continued vnto that place where the Centre of the Shot ſhall in his courſe ſenſibly begin to decline from the ſaid continued imagined Axis downewards.

*Demand 6.*

That the viſib'le right line made or imagined to paſſe from the Breech of the Peece to the Mouth of the ſame vpon the higheſt ring or ſuperficies of the Mettall (ſhe lying on her Cariage and Platforme) be called the *Middle lyne* of the Peece.

*Demand 7.*

That the viſible right line made or imagined to paſſe from the Breech to the Mouth vpon the ſurface of the Mettall vertically ouer the Axis of the Bore of the ſame Peece (ſhe lying vpon her Cariage and Platforme giuen) be called the *Large lyne* of that Peece.

*Demand 8.*

That the ſhorteſt diſtance between the verticall plane of the Axis of the Body of the Peece, and the verticall plane of the Axis of the Soule or Bore of the ſame Peece, taken vpon the Baſeringe at the Breech thereof (for the ca- riage Peece and Platforme giuen) be called the *Large* of that Peece.

*Maximes of Naturall Philoſophy neceſſary to be firſt knowne.*

- 1 **E**Very motion in the world endeth in reſpoſe.
- 2 All motions are made vpon ſome quantity.
3. Euery ſimple Body is eyther *Rare* and *Light*, or elſe *Thicke* and *Hea- wy*, and according to theſe differences it is Naturally carryed towards ſome part.
- 4 The world hath high or vpwards, and low or downewards, and the Low dependeth vpon the influence of the high.
- 5 The rare bodies mount, the ſier, more then the Ayre. The thicke and groſſe bodies deſcend, the *Earth* more then the *Water*.
- 6 The lighter are more moucable then the heauier.
- 7 Nothing worketh Naturally in that which is wholly like or wholly diſlike, but in that which is contrary to it, and more feeble.
- 8 The *Forme* working, is ayded by the *Qualities*, as the matter ſuffering, which ſuffereth by the quantity.
- 9 *Nature* is extremely curious, as well of her perfection, as of her con- ſeruation;

seruation; and then when all things conspire.

IO Aswell the Action that commeth from the Agent, as the *Passion* from the Patient hath proportion.

II Accident taketh his vniity from the Subiect, and goeth not from one thing to another.

### THEOREM. I.

*Euery Corporall thing reposeth in its naturall place.*

**L**ight bodies <sup>mount</sup> ~~move~~ towards the heauens vpward, and heauy bodies towards the Earths centre downwards, each Body is light or heauy, if it be heauy, it will then ~~move~~ <sup>mount</sup> downwards; if light vpwards. Now the circular motion is neither vpwards or downwards, therefore no Motion can be circular but by violence.

### THEOR. 2.

*Motion may be made in any place within the Moones Orbe.*

Euery thing that is within the Lunar Orbe may make motion or change,

### THEOR. 3.

*Before any thing mooueth towards its Naturall place, from its first being, it goeth stretching vnto the naturall measure.*

Neither augmentation nor dimiution is made but onely by changing of the qualities or formes, for the qualities alone (incontinently following new generation) doe cause eyther stretching or shrinking. And true it is, that in such Moouings as tend vnto the entire ruine of the formes, the iust demensions are not found to be but either greater or lesser according to the quantity agitating most forceably therein, and so it mooueth most violent and longest.

### THEOR. 4.

*Nature admitteth no Emptynesse.*

Nature pursueth and entertaineth perfection as much as is possible. Now the perfection of Motion is the end thereof; namely the repose, that the simple Body would finde eyther vpwards or downwards in all places: therefore in the Elementary vniuerse, they affect their repose either vpwards or downwards. So there is not by Nature any such thing as vacuity, for the auoiding of which, nature maketh heauy things mount, and light things descend, whereby marueilous things are performed. As we may see by our Pumps, which make water ascend as high as the clouds, and by the Spiritualls the ayre is retayned beneath. And diuers other effects seeming so miraculous to such as see them as they cause the to wonder therat. For whence commeth it that a vessell of Marble fild with water, when the water commeth to be frozen into yce, that it break the same though a foorthicke but that the water thickneth therby, and so breaketh the volume of the ordinary quantity thereof, the cause preceeding, the effect followeth. So also a

narrow



I hope with *Scapes* that alter not the fence,  
 The friendly Readers will for Loue dispence:  
 And those that are in th'Errata here exprest,  
 His louing Pen will mend, and thus digest.

| Page | Line       |  |
|------|------------|--|
| 4    | 8          | For bodies more, <i>r. bodies more.</i>  |
| 18   | 13         | in the totall for 2536, <i>r. 2356</i>   |
| 1b.  | 40         | for 31701, <i>r. 31941, &amp;</i>  |
| 7b.  | 43         | for 49861, <i>r. 1492101</i>   |
| 19   | ult.       | for the 2 and carie, &c. <i>r. the 2 and 2 times 6 make 12,<br/>set downe the 2 and carie 1, &amp;c.</i>                                       |
| 1b.  | 10         | for 149861, <i>r. 149210</i>   |
| 20   | ult.       | for files and flank, <i>r. Front</i>   |
| 21   | 1          | for Front multiply, <i>r. Flank divide.</i>  |
| 1b.  | 3          | for Front, <i>r. Flank</i>   |
| 22   | 10         | for double, <i>r. double 3 and haue 6</i>  |
| 1b.  | 22         | for $\frac{1}{100}$ , <i>r. <math>\frac{1}{1000}</math>.</i>   |
| 1b.  | 23         | for thirty, <i>r. three hundred.</i>   |
| 23   | 7          | for $\frac{1}{10}$ , <i>r. <math>\frac{1}{100}</math>.</i>   |
| 27   | 22         | for subscribed, <i>r. circumscribed</i>  |
| 29   | 36         | for B to D <i>r. B to C.</i>   |
| 30   | 41         | for parts the, <i>r. parts giue the.</i>   |
| 31   | 1          | for 8000, <i>r. 24000.</i>   |
| 1b.  | 2          | for 66 <i>r. 100.</i>  |
| 32   | 1          | for 10, <i>r. 29.</i>  |
| 35   | 16         | for neere ioyned, <i>r. neere or ioyned.</i>   |
| 1b.  | 26         | for and both the ancient, <i>r. and the ancient.</i>   |
| 39   | 19         | for, For that now, <i>r. That now.</i>   |
| 39   | 27         | for Ayming, <i>r. Ayme at.</i>   |
| 42   | 24         | for, For I say, <i>r. I say.</i>   |
| 44   | 3          | for $\frac{1}{2}$ , <i>r. <math>\frac{1}{10}</math> and in the Table vnder for deg. <i>r. heights,</i><br/>and for dc, <i>r. lengthes.</i></i> |
| 45   | 30 and 31, | for leuelleth, <i>r. leuell.</i>   |
| 53   | 13         | for $1\frac{1}{2}$ , <i>r. <math>17\frac{1}{2}</math>.</i>   |
| 54   | 42         | for 143, <i>r. 250.</i>  |
| 67   | 43         | for afterwards, <i>r. forwards.</i>  |
| 69   | 24         | for 16, <i>r. 100.</i>   |
| 78   | 22 and 23, | for ordinary Culnering, <i>r. lessned Culnering.</i>   |
| 94   | ult.       | for Table following, <i>r. former Table.</i>   |
| 97   | 39         | for right range, <i>r. dead range.</i>   |
| 105  | 17         | in the Table for 424, <i>r. 524.</i>   |
| 106  | 35         | for 1000, <i>r. 1000.</i>  |
| 142  | 33         | for to disolue, <i>r. to vapour.</i>   |
| 144  |            | Betweene lynes 5 and 6, <i>r. The 73 Chapter.</i>  |
| 146  | 6          | for 2 sic, <i>r. adde.</i>   |
| 1b.  | 27         | for topped, <i>r. Tapped.</i>  |
| 1b.  | 31         | for top, <i>r. tap.</i>  |

*The leaf should be  
 placed before the preface.*



narrow necked bottle filled with liquor, and turned the bottome vpwards, yet retaine the liquor from running out : because Ayre cannot enter therein, to fill the place, whereupon we may iudge that the Law of fulnes is more generall, and precedeth that of the Mouing of simple Bodies.

THEOR. 5.

*Every Body hath a place.*

A poynt which cannot be marked in essence, not hauing any parts, is no Body, and therefore is contrary to the Hypotheses. But a Body hath place of dimensions, so if the surface of the body which approacheth on all sides, and toucheth euery where, tying the superficies to close the body, it is then in such a place as hath the very same dimensions within, that the body hath without, or else there must be emptinesse, which by the precedent were absurd.

THEOR. 6.

*A Body rarifying its selfe, the place thereof increaseth as the Body increaseth.*

As a Body of Earth that then contained one solide foote in measure bee made water, which adding thereto, one other solid foote, the place also must encrease, from one to two solid feete, or else it hath not the same iust dimensions within, that the body hath without, and so it is not the place of that body of water; so if the place also were greater then the body filled, there must in that place be emptinesse betweene it and the body, which were absurd: therefore the place encreaseth as the Body rarifying doth.

THEOR. 7.

*Two Bodies cannot be together in one and the same place.*

If seuerall Bodies could be together, all the members of one same Body might also haue one and the same place, and each part might one fall into the range of the other, which were to take away from the quantity, the true Nature thereof, and which by its essentiall property setteth out the parts seuerally one from another: Neuerthelesse that some sleight apparances haue seemed to yeeld a suspition that it might be so: As take a vessell full of ashes finely sifted, and you may put into the same as much water also as would without the ashes haue filled the vessell. So by the vessell full of ashes, and the same vessell full of water, two Bodies seeme to bee in one place: So into a glasse full of water you may put in many peeces of money before it runne ouer. And likewise an yron heated red hot, is it not fire and iron together, and so two bodies in one place?

No, for these are but illusions: for the first vessell fild with ashes (that are very volatyle) part flyeth, and the rest hath place doubtlesse, but the water swelleth by meanes of its vnctuousnes receiued, vnto a roundnes aboue the brims of the vessell as much as the true body of the ashes is ouer, and yet spillet not. And so in the glasse likewise the supream surface of the water swelleth as much aboue the brims of the glasse as the Body of the peece of money hath receiued place. And lastly, seeing it is but the forme of fire or quality of heat liuely lent vnto the yron, it can not be truly said, that



therefore two bodies are together therein, for there is but one matter vnder those two formes hauing but one quantity, so neyther are two bodies mingled in one Place, nor penetration of dimensions, which is impossible: from whence the ingenious practizer may extract admirable effects,

## THEOR. 8.

*A place filled cannot receiue another Body in without expelling the former one.*

Amongst Bodies, some are hard and robust, and some are soft and tender, so that if vnto a soft body in a Place, a hard body should enter, it would violate the dimensions of the soft body. And seeing *Plato* himselfe said there was no solid things, but terrestiall, this difficulty were fit to be resolved. *Plato* then spake not of Mathematicall solidity, or of shorter or longer dimensions, but of that rather which is called firmenesse or hardnesse: as we vsually say stone to bee more solid then wood, and yron to bee more solid then stone: also if we haue onely respect to the demonstration, then there is as much solidity in a Cubick foote of Butter, as in a Cubick foote of Marble stone: And so if the Ayre or Water doe giue way to Bodies that are more firme or heauie, it is not because they are lesse solid, but that they are more moueable and lighter. Therefore if a vessell full of Ayre or Water had an other hard or heavy Body put thereinto without expulsiō of the Ayre or Water proportionally. Then two Bodies would be in one place, which is a thing by the former impossible.

## THEOR. 9.

*The Resistance of the Moued proportioned to the Mouer, furthereth the Motion.*

The *Action* and *Passion* must be proportionalls amongst themselves: It were but vaine for the Agent to giue a strong stroke, if the thing that is to be moued receiue it not: And it cannot receiue it well, if there be not contrariety, (which resteth in the Resistance) for so in the object that should obey entirely, there would be no Action at all: For nothing worketh that is wholly vnlike. Contrariwise, also if the Resistance were wholly like, or equall to the force of the stroke, there would bee no Motion: For nothing worketh in that which is wholly like, wherefore there must be a proportion exercised betweene the Mouer and the Resistance, to attend the entire impressiō of the stroke: for if the Resistance be greater then the force of the stroke, the Chaser shall be chased: for of two Aduersaries, the most violent is the Master. Besides, the more an Action is continued, the greater it is. Therefore the longer time the Mouer toucheth the Moued in expulsion, the more the force of the Mouing impressed, is entertained, and longer doth it endure. And this is the reason why the Powder, Wadd, and Shotte, are driuen into a Peece, but with meane force: For if the Shott bee too loose put in, it would not well receiue the fury of the Powder enflamed, and the force of the blowe will be but weake. And when the Shot goeth in too stiffe, or is forced in too hard, or the Powder over-rammed, then the Powder Comes being thereby broken, will bee cloyed so close, that it will blowe much of the force thereof out of the Touch-hole, before the Shott bee discharged:

MAX. 7. EL.  
Artill.

By the same,

charged: But if the Shot were onall or too high, and being forced in, doth stick by the way; it breaketh the Peece, and causeth often lamentable and dangerous effects, without performing the expected seruice.

THEOR. 10.

*Fire taking the Powder, of necessity the Shot must be driven forth, and the Peece discharged.*

At the moment of the inflammation of the Powder, the Peece must necessarily shoote off, and discharge the Shot, for the Powder is then in his last power to be enflamed, and the Fire taketh in an instant. Now that which is burned is rarified, and so extends it selfe (*Fire being the rarest of the Elements*) but being so blocked vp within the concaue ciillnder of the chamber, that it is impossible to extend it selfe, vnlesse it remooue the shot which occupyeth the place it must extend into (for penetrate the Mettall at the Breech and sides it cannot) Nature then otherwise absolutely commands this extention by the perduction of this new forme of fire. Wherefore from a Naturall violence, and from a force vnto which all things conspire, and nothing can resist, the shot is chased, and the peece discharged: whereby wee may see how Philosophy and the knowledge of Natures workes, may guide vs to admirable inuentions, The impossibility of the penetration of dimensions and the necessity of this fierie generation, when the Actiue forces are vnited to the passiue, this hath lead our predecessors by the hand to the fabricke of the fearefull Machyue the Gunne beyond all that euer the Art of Man could thinke vpon.

THEOR. 11.

*The Bullet begins to flye before the perfect firing of the Powder.*

The Powder is not perfectly fired, vnlesse it be all on fire, now before the forme taketh into the matter (to giue it that being) and to change the nature thereof. Namely, from the first rudiments of being, the Matter rarifieth, for the qualities of the Agent preceedeth. Therefore the Place augmenteth, which cannot be vnlesse the shot quit the place: wherefore it be- ginneth to suffer before the instant of perfect firing of the powder; for that depart is so sodaine, that sometimes a great part of the powder goeth out whole and vn-fired, which could not be if it were perfectly enflamed, and therefore the greatest inflammation maketh the greatest force.

THEOR. 12.

*The force of the stroke dependeth on the swiftnes of the Course.*

To Strike is a matter of Mouing, as is the Time & the Quantity or the distance vpon which it is made, which if the time be short wherein it is carryed home as farre distance, then it is called *Swift*: Therefore the shorter the Time is, the swifter and stronger is the stroake; Now to Move more is to act more in corporall things, and the more quicke the Action is; so much the stronger. Wherefore according to the measure of the Agents motion, the swiftnesse of the course, the stroake is reckoned strong. This is the *Enginieres Helicon* from whence the most of their strong Engins are drawne, the great-

nesse of the *distance* is nothing if the *Time* be long, nor the shortnes of the *Time* if the *distance* be short.

## THEOR. 13.

*There can be no moving in Action made more violent then with a peece of Ordnance.*

The volume or extent of the rarefaction being ten times as much when it becommeth fire as it was when it was earth, Fire being ten times more  
*By the 5. Max.* rare then *Earth*: and of all Natures *Agents* the fire, and of all the *Qualities*  
*By the 4. Theor* *heat* carryeth away the prize for violence, seeing the generation of fire in the *Powder* is momentary. Therefore the time of the rarefaction is extremely short, as being of one onely instant, if any moment before that generation begin not to drive out the Bullet, the stroke must then be extremely violent, seeing that the distance is very great in respect of the shortnesse of the  
*Arist. 2. Meteor* *Time*, unto which we may adde the quicknes of the flame, which is such, that it will not stay here below the least part of time but will flye away.

## THEOR. 14.

*The longer the Chase of the Peece the stronger the stroke.*

The generation of this fire being made in an instant, the rarity ariuerh at once, the violence prest to chase out the shot, the flame flyerh making it issue out, and the Ayre to come in to preuent emptinesse, and all as it were in an instant. Therefore the longer the Chase of the Peece is (being fortified and loaded accordingly) the more effectuall shall the Action be, and the stroke the more violent, whereby it commeth to passe that long *Culuerings* carry further then great *Canons* although with lesse powder: yet the force is better entertained by their greater length and better fortification to endure the full charge of powder.

*By the tenth Theoreme.*

## THEOR. 15.

*A Peece reuerfeth when it dischargeth.*

When the *ignition* beginneth at the bottome of the concaue of the Peece, at the *Touch hole*, the peece reuerfeth at the instant of the rarefaction, the vent it can find, being onely forth of the *Touch-hole*, beateth backe vntill the shot be gone out. And this maketh a Peece Mounted to shoote from alof vpwards, to reuerse more then vpon the leuell or from aloft downewards: for that the Shot which is heauy, and consequently violent in his naturall descending when it is forced vpwards, it resisteth more then either shot downewards or leuell; and so the more the waight of the Bullet resisteth, the force that driuerh out the shot, which at last it is constrained to obey and to yeeld the more to the reuerse. But the Metall suffereth the more when it is resisted, as some men cause it by making a Rampart behind the breech of the Peece, against which it may stay, thereby to augment the force of the shot. From whence we may gather that the impression of Reuerse is onely whilst the shot is within the Peece: besides the *Touch-hole* being made neere the bottome of the concaue doth not onely augment the reuerse more then if the *Touch-hole* were in the midst of the powder, or rather more forwards  
 whereby



whereby the powder would fire together in the lesse time, and little or none goe out vn-fired, reuerse lesse, and make the fury of the Shot the greater : And this maketh the small Pistolls so pierced, to out shoot those that haue their touch-holes peircd at the bottome of their bores.

THEOR. 16.

*A Peece of Ordnance shooteth further in a right line, from a low upwards, then from above downwards, except Perpendicularly.*

To the shot made vpwards, there is greater resistance of the bullet, but when a shot is made downwards, the force doeth not onely worke, but the waight of the shot also by it's naturall heauinesse, the bullet easily descends from the strait line, falling vnder expectation; whence it commeth, that the right Range is further in Mountures, then in any Imbasure, for this proposition is not to be vnderstood so at the going out of the shot, (for all right Ranges, are all equally strait;) neuerthelesse, that it is shortest shooting from aloft downwards, and longest vpwards, and the leuell being the meane betweene them both.

THEOR. 17.

There are three chiefe most materiall and efficient causes of the greater violence of any shotte made out of great Ordnance, viz. the Powder, the Peece, and the waight of the Bullet.

THEOR. 18.

*Powder* is compounded of three Principles, or Elements, *Saltpetre*, *Sulpher*, and *Cole*, whereof *Saltpetre* is it that giues the chiefe violence.

THEOR. 19.

Albeit *Saltpetre* bee indeed the onely, or most materiall cause of the violence; And that Powder commonly found most forcible that is richest of *Petre*, yet is there a certaine proportion of Perfection of these three Components. And that in such sort, as if you adde more or lesse *Petre*, the violence shall abate.

THEOR. 20.

Although Powder bee also the most efficient cause of the force and violence of any shotte, yet is there such a proportionall charge of Powder to bee found for euery seuerall Peece, in regard of the proportion of her charged and vacant *Cylinders*, as giuing more, or lesse, then the same proportionall charges, it shall diminish, and not increase the violence of the shotte.

THEOR. 21.

If any two Bullets of equall quantitie, but vnequall waight, bee let fall from any loftie place to the Horizon, the more weightie, shall euer fall the more swiftly: albeit, not porportionally to their weight; which Axiome is indeed erroneous, albeit, a great Philosopher hath auctored the same.

THEOR. 22.

If two equall Bullets of different waight, be shot out of one and the same Peece

Peece directly to the Zenith, both Bullets being of massie mettall, and charged with one quantity and kinde of Powder, the lighter shall alwayes outflie the heauier. But such kinde of Bullets they may bee charged with all, as the heauier shall outflie the lighter, although they be both discharged with the same Peece, and quantity of the same Powder.

## THEOR. 23.

There is such a conuenient waight to be found of the *Bullet*, in respect of the *Powder* and *Peece*, as the Bullets mettall being either heauier or lighter then that waight, shall rather hinder then further the violence or farre range of the shot.

## THEOR. 24.

There is such a conuenient Proportion to be found of the length of euery *Peece* to his *Bore* or Bullets *Diametre* in respect of the *Powder*, and waight of the Ball, as either encreasing or diminishing that proportion it shall abate also, and hinder the violence of the shot.

## THEOR. 25.

This proportion exactly found in any one *Peece*, doeth not hold in all other, and yet the difference and alteration is such, as may be reduced to rules certaine.

## THEOR. 26.

Besides these three most materiall causes of violence, the Randons also and different Mounts of Peeces, cause a great alteration, not onely of the farre shooting of all Peeces, but also of their violent Batterie. And albeit the different alterations are very intricate and strange, yet haue they a *Theoricke* certaine.

## THEOR. 27.

There are also many other Accidentall alterations happening by reason of the winde, the thickeesse or thinneesse of the Ayre, the heating or cooling of the Peece, the different manner of charging by Ramming fast or loose the Powder, by close or loose rouling or lying of the Bullet, by the vnequall recule of the Peece in his Carriage or deformitie of the Axtree, with diuers other such like, whereof no rules certaine can be prescribed, to reduce these vncertaine differences to any certaine proportions: but all these are by Practise, Discretion, and Iudgement to bee considered, and vniformely guided and performed in their best perfection.

## THEOR. 28.

Any Peece mounted 50. grades aboue the Horizon, throweth his Bullet most violently immediatly after the discharge, and then the motion groweth slower, till the Bullet be come to his vtmost Altitude, and then by Perpendicular falling, encreaseth by little and little, his swiftneesse againe, euen till it cometo the Horizon. But at all other Randons, it falleth not so out.

## THEOR. 29.

Albeit in the subtiltie of *Geometricall Demonstration*, no part of the Bullets violent

violent motion, can bee truely auerred a right or direct line, saue onely the Perpendicular : yet in these experiments *Mechanicall*, That first part of the violent motion (I meane so farre as the peece is said to carry *Point-Blanke*) being so neere the direct, is, and may well be termed the direct line. As all water levels are accounted in all Mechanicall operations, the perfectest levels and directest lines. Albeit the subtiltie of Geometricall Demonstration; doeth finde them not right or direct, but Curue or Circular.

THEOR. 30.

When any Peece is mounted directly to the Zenith. Then doth his motion violent (being in that scituation directly opposite to the naturall) carry the *Bullet* in a perfect right line, directly vpward, till the force of the violence be spent, and the Naturall motion haue gotten the victorie. And then doeth the Naturall returne the *Bullet* downe-ward againe, by the very same perpendicular line. And so is the whole motion of the *Bullet* in this case a very direct perpendicular to the Horizon.

THEOR. 31.

But if any peece bee discharged vpon any Angle of Randon, albeit the violent motion contend to carry the *Bullet* directly by the line Diagonall; Yet the perpendicular motion being not directly opposite, doeth though vnensibly, euen from the beginning by little and little, draw it from that direct and Diagonall course. And as the violent doeth decay, so doeth the naturall encrease : and of these two right lined motions, is made that mixt Curue Helicall Circuit of the *Bullet*.

THEOR. 32.

Any peece therefore discharged at any Mount or Randon, first throweth forth her *Bullet* directly a certaine distance, called of some Gunners their *Point-Blanke Range*, and then it maketh a Curue declining Arke, and after finisheth either in a direct line, or high enclining towards it.

THEOR. 33.

The further that any peece shooteth in her direct line, commonly called *Point-Blanke*, the deeper also she pierceth in her battery, if the bullet bee not of substance bricke or frangeable.

THEOR. 34.

The more ponderous a *Bullet* is, the more it shaketh in Battery, albeit, it pierce not alwayes so deepe, as the lighter or lesser shot conueniently charged.

THEOR. 35.

Any two Peeces of Battery Ordinance, charged with one kinde of bullet, and shot into one Rampire of massie vniforme kinde of Substance, shall euer make their profundities of piercing proportional, to their leuel Ranges Horizontall; and if they be discharged, either leuell or at one grade of randon, and at like distance.

THEOR. 36.

Any two Peeces of Battery, discharged into any Rampart, of vniforme massie



massie substance, shall euer make their piercing depths proportionall to their lines Diagonall, albeit these Peecces be discharged from different Randons, so as they batter at like distance.

## THEOR. 37.

As *Archimides* line Helicall or Spirall, is made by the direct motion of a point carried in a right line, while that right line is Circularly turned as Semidiameter vpon his Circles Center: So is this Artillery Helicall line of the bullets Circuit created onely by two right lined motions, becomming more or lesse *Curue* according to the difference of their Angles, occasioned by the seuerall Angles of the Randon. Whereupon by demonstration Geometricall, a *Theoricke* may bee framed, that shall deliuer a true and perfect description of those *Helicall* lines at all Angles made betweene the Horizon and the Peecces-lines Diagonall.

## THEOR. 38.

These direct or Diagonall lines, are alwayes longest when the Peecces Axis is directed to the Zenith. And alwayes as the Peecces Axis declineth more and more to the Horizon. So doe the Diagonall lines grow shorter, and at the leuell Horizontall, shortest of all.

## THEOR. 39.

These direct lines Diagonall, albeit they encrease in length at every grade of Randon from the Horizon to the Zenith, yet is not their encrease vniforme or proportionall, either to their degrees of Randon, or Horizontall Ranges, nor yet to their Circuits or Altitudes, and yet such as may be reduced to a *Theoricke* certaine.

## THEOR. 40.

The middle *Curue* Arks of the bullets Circuits, compounded of the violent and naturall motions of the bullet, albeit they be indeed meere Helicall, yet haue they a very great resemblance of the Arkes Conicall. And in Randons about 45. they doe much resemble the Hyperbole, and in all vnder the *Ellipsis*: But exactly they neuer accord, being indeed *Spirall* mixt and *Helicall*.

## THEOR. 41.

Any Peece discharged at any one Randon with like bullets, and seuerall charges of powder, shall make both their lines Diagonall, and Curue Circuits of different longitude, but the Curue Arkes shall alwayes bee as Parallels, and their Longitudes proportionall to their lines Diagonall.

## THEOR. 42.

The last declining line of the *Bullets* Circuit, albeit, it seemes to approach somewhat to the nature of a direct line againe, yet is it indeed still *Helicall* and mixt, so long as there remaineth any part of the motion violent. But after that is cleane spent, the rest of his course to the Horizon is direct, and Perpendicular, and a perfect right line indeed, which is best discerned in those Grades of Randon, which are betweene the Zenith and the Mount or Randon Aquorizontall.

THEOR.

THEOR. 43.

This declining line doth alwayes make a greater and greater Angle with the Horizon, As you raise the Peece to a greater Mount, till you come to the Mount *Æquorizontall*, about which point the same declining line becommeth Perpendicular before the *Bullet* fall to the Horizon.

THEOR. 44.

The Horizontall Ranges in all Peeces mounted from the Horizon toward the Zenith, doeth not still encrease, but at euery Grade of Randon are longer, till you come to the point or mount *Tropicall*, commonly called the vtmost Randon, which hath beene generally thought to bee the grade 45. but is not so. An from that *Tropicall* grade vpward, the Ranges decreace againe till you come to the grade *Æquorizontall*, so called because the *Bullet* then falleth a like distance to the leuell Ranges.

THEOR. 45.

This *Æquorizontall* Grade is as farre distant from the Zenith, as that Grade is from the Horizon, which shall cause the peece to shoor in the Horizontall plane, a distance equall to his highest Altitude, or longest line Diagonall.

THEOR. 46.

The mounting of any peece aboue his *Æquorizontall* grade, doeth still decrease her Horizontall Ranges, euen till it come to the Zenith. But in a proportion different from any of the former, her *Bullet* ending euery of those Circuits in a direct line perpendicular.

THEOR. 47.

The Graduall encrease and decrease of these Ranges Horizontall, albeit they are equall in the Quadrant, yet are they neither equall nor proportionall in the Horizon, neither the Ranges nor their Interualls. Neither compared betweene themselves, nor yet conferred with the Chords or Sines of their Arkes. And yet is there such a kinde of proportionall encrease and decrease of the proportion of their Interualls, as may be reduced to a *Theoricke* certaine.

THEOR. 48.

The *Tropicall* Grade commonly called the vtmost Randon, is not as hath beene generally supposed the Medium, or Middle betweene the Horizon and the Zenith, viz. 45. but rather betweene the Horizon and the Grade *Æquorizontall*, which will fall out much higher 50. from the Zenith, and 40. from the Horizon.

THEOR. 49.

The highest *Altitude* of any *Bullet* Circuit is farthest distant from the Peece, when shee is discharged at her vtmost Randon, and at all other Randons either aboue or beneath that *Tropicall Point*: That highest *Altitude* is euer least distant, and the bases of these Triangles doe euer encrease to the Randon *Tropicall*, and decrease after, euen as the Horizontall Ranges; but in proportion more different euery one from other.

D

THEOR.

## THEOR. 50.

The *Altitudes* of the Circuits of Randons doe not encrease and decrease as their Ranges *Reciprocally*, but from the Horizon in every Grade to the Zenith, doe still encrease, but yet neither equally nor proportionally, neither conferred betwene themselves, neither yet with sines or Chordes of their Arkes of Randon. And yet the encrease and decrease of their Interualls proportions, such as may bee reduced to a *Theorieke* certaine.

## THEOR. 51.

The *Hypothenusall* lines of all these different Circuits carry a mixt proportion of the composition of the proportions of these *Altitudes* and *Bases* by addition of their Squares; But are not proportionall to the lines Diagonall of their corresponding Angles of Randon.

## THEOR. 52.

Any two peeces of Ordinance being mounted to any one Grade of Randon, shall make their Horizontall Ranges of their Bullets proportionall to the *Altitudes* of their Circuits.

## THEOR. 53.

The Ranges Horizontall of any two Peeces discharged at one Randon, will bee alway proportionall to their lines Diagonall of the same Peeces Circuits.

## THEOR. 54.

The Horizontall leuell Ranges of any two Peeces of Artillery are euer proportionall to the vtmost Ranges Horizontall of the same Peeces.

## THEOR. 55.

And two peeces whatsoeuer, discharged at one Randon, doe euer make their lines Diagonall, and lines of Altitude proportionall, howsoeuer the proportions of their charges vary.

## THEOR. 56.

And two peeces whatsoeuer, discharged at one grade of Randon vpon any enclining or declining plane: shall neuerthelessse make their Ranges proportionall to their lines Diagonall, and Altitudes of those their different Ranges. Albeit the peeces bee charged with a different kinde of proportion of Powder and Bullet, so as the shot be made in a faire Calme day, as is in these cases alwayes presupposed, because for such vncertaine Accidents there cannot certaine Rules Artificiall be prescribed.

## THEOR. 57.

One Peece discharged, at seuerall Randons vnder the vtmost Randon, being a like charged and discharged, and the Peece also of one tempest, at both times, shall euer make seuerall Ranges. But if shee bee discharged at seuerall Randons, the one aboue the *Tropicke* point, the other vnder: Then may their Ranges bee equall notwithstanding their Randons, Lines Diagonall, *Altitudes*, *Bases*, and Lines *Hypothenusall*, be all different.

## THEOR.



THEOR. 58.

When any Peece (being twice discharged at feuerall Randons, the one aboue, the other beneath the *Tropike* point) shall make the same or equall Ranges in a *Horizontall* plane. The middlegrade betweene those feuerall Mounts, is very nigh the grade of vtmost Randon: and the Peece Mounted to that middle grade, shall then make very nigh his vtmost *Horizontall* Range.

THEOR. 59.

The grade of vtmost Randon or point *Tropicall* of any Peece in a Plane *Horizontall*, shall not be the *Tropicall* grade of that Peece, in a plane declining or inclining, but an other Peculiar to that Angle of Inclination or Declination.

THEOR. 60.

Any Peece discharged at his grade of vtmost aduantage *Horizontall* vpon a Plane inclining, shall not make so great a Range as on his Plaine *Horizontall*: But contrariwise on a Plane discending shall make a farther Range.

THEOR. 61.

A Peece discharged first at his due leuell, and againe at his *Æquorizontall* grade, albeit in the plaine *Horizontall* they make equall Ranges, yet in Planes declining they shall not so doe, but alwaies the Leuell Ranges shall euer out-shoot in all declining Planes the Range of that grade *Æquorizontall*.

THEOR. 62.

A Peece discharged at any grade from the Zenith to the grade *Æquorizontall*, shall alwaies make a greater Range in any Plane enclining or declining, then on the Plane *Horizontall*.

THEOR. 63.

In all Planes enclining at all Randons betweene the *Horizontall* Leuell and point *Tropicall*, all Peeces shoote farther in their Planes *Horizontall*, then on any Planes enclining, and contrariwise in Planes declining: But aboue the *Tropike* grade not alwayes so, but sometimes, and not alwayes contrary.

THEOR. 64.

In any Plane whether it be enclining or declining, if any Peece of Ordnance be discharged, being *Paralell* or Equidistant to that Plane, and the first graze or bound noted. If the same Peece be with like charge vniformly charged and discharged at such an high grade of Randon, as may cause the *Bullet* Range the former Distance: That middle grade of the Quadrant, which lyeth betweene these two Mounts, shall be very nigh the grade of vtmost aduantage, for that enclining or declining plane. The which in all

planes enclining, will be about the utmost Range *Horizontall*, and in all declinings vnder.

## THEOR. 65.

In all enclining or declining planes, as the grade *Tropike* of greatest advantage doth varie; So doth also the proportions of their Ranges, at every grade of Randon differ, whether they be accounted from the Zenith, or Horizon Planes, enclining or declining. But yet in such an assured and certaine manner as may be reduced to a *Theoricke* perfect.

## THEOR. 66.

In all Grades of Randons, & in all manner of Peeces, whether the planes be *Horizontall*, or vary by Inclination or Declination, the *Diagonall* Lines are still proportionall to those of the planes *Horizontall*, respectiue taken by Graduation from the Zenith, in all Peeces whatsoeuer. But the Lines of *Altitudes*, their *Bases* and Lines *Hipotenussalls* are euer different in euery seuerall Angle, both of Inclination and Declination, and vary by such a different Proportion from the *Horizontall*, as they are to be discovered by a seuerall Methode of Calculation.

## THEOR. 67.

Such *Theorikes*, *Scales*, and *Instruments*, may be framed for the Inuention of these strange proportions of *Altitudes*, *Lines Diagonall*, and *Ranges Horizontall*, as thereby with the aide of *Calculations Arithmeticall*, and some Rules *Geometricall*, a man may exactly and readily discover the true Circuits and Ranges of the *Bullets* of all Peeces of Ordnance whatsoeuer, mounted howsoeuer; and vpon all grounds or planes enclining, or declining, that can be Imagined.

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Definition

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## DEFINITION OF ARITHMETICKE.



*Arithmetick* is the Art to number well, and is the ground of the Mathematicks.

### *Of Notation or Numeration.*

The Characters are 9 significant, as 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, a Cypher, Remembring onely One, Ten, a hundred, reckon all your figures or places from the right hand towards the left, alwayes making a prick or dash ouer every third figure, omitting the first: As suppose this number were to be valued, 4<sup>.</sup> 6 7 2<sup>.</sup> 3 5 6. So herein you find two pricks; then reckoning backe againe from the last figures on the left hand towards the right hand, name after each figure pricked so many times a thousand as there are prickcs towards the right hand, saying 4 with his prick, and the next prick is foure thousand thousand, then say sixe hundred seuenty two thousand, three hundred fify sixe, and so of all others bee the places neuer so many, you shall name their true values to their numeration, being the common beginning is knowne well enough: This shall suffice.

## The foure Principles of Arithmeticke in whole Numbers.

### *Addition.*

**T**O adde is to Collect or assemble many Summes into one totall beginning at the right hand, and so proceeding towards the left: as by the example following. To adde 2356 with 5876, place them so vnder one another, that all the first figures of the summes towards the right hand stand right vnder one another: and likewise all the second figures and third, &c. of each sum directly vnder his fellow first, second, or third, &c. Thus, as 6 vnder 6, & 7 vnder 5, and 8 vnder 3, and 5 vnder the 2, and then saying  

$$\begin{array}{r} 2356 \\ 5876 \\ \hline 8232 \end{array}$$
  
 6 and 6 make 12, whereof set downe the two vnder the two sixes, and carry one for the other tenne vnto the next summe to adde to 7 and 5, saying one and seuen are eight, and sixe makes 12,  
 D 3 place



place the 3 thereof vnder the 7 and 5, and carry one againe for the other ten to the next place, saying one that I carry and 8, make 9, and 3 make 12: Of which I set downe the two, and for the tenne againe I likewise carry one vnto the next place, saying, one (that I carryed) and five make sixe, and two make eight: which being the last, I set it right vnder the five, & 2. and finde that they make totally 8232.

### Substraction.

**T**O Substract is to take a lesser summe out of a greater, and to note the remainder or difference, beginning also at the right hand, and proceeding towards the left. As to substract 5876 from 8232 placing as before in Addition each first, second, and third figure of the other thus

|      |            |
|------|------------|
| 8232 |            |
| 5876 | reads 2356 |

As 6 vnder 2, and 7 vnder 3, and 8 vnder 2, and 5 vnder 8. And then saying 6 out of 2, cannot be, but borrowing tenne from the next place maketh the 2 to bee 12, then 6 out of 12 there remaineth 6: which set downe vnder 6 and 2, then say 7 out of 3 lesse one that was borrowed cannot be done, but 7 out of 12, that is 1 tenne borrowed out of the next place and 3 lesse 1, that is 2 making 12 remaineth 5: which also set downe vnder 7 and 3. Then say 8 out of 2 cannot be, but 8 out of 11, that is, one tenne borrowed of the next, and one lent out of the 2, maketh together 3 to remaine. Lastly, say 5 out of 8 lesse one lent, that is 5 out of 7 resteth 2. And so you shall finde that 5876, being taken from 8232 will leaue 2356, which the precedent Addition prooueth true for the remainder.

### Multiplication.

**T**O Multiply signifieth to augment a summe by it selfe, or by some other number, placing the lesser which we commonly name the Multiplier vndermost, so that no figure towards the right hand outreach other, (except Cyphers) and then beginning at the right hand, and proceeding towards the left, still multiplying euery figure of the vppermost summe by each figure of the lower, and set the products vnder the line: as the example here following will demonstrate to the eye. And for the more easy solution of this proposition, it will be necessary to know by memory the products of the multiplication of the 9 simple Characters, 1.2.3.4.5.6.7.8.9. amongst themselves. As five times 7. make 35, and 9 times sixe make 54, &c. Now 4563 are giuen to be multiplied by 327. Place the lesser number vnder the greater with the first of it towards the right hand vnder the first of the other, & then draw a line vnder them thus, And say 7 times 3 make 21. Place the 1 vnder the 7 and 3, and carry 2 for the 2 tennes vnto the next place, and say 3 time 6 make 18, and 2 that I carryed in memory make 20: whereof I set downe the 0, and carry the 2 to the next, saying 7 times 5 make 35, and the 2 I bore in minde make 37: whereof I set the 7 vnder the 5 and 3, and carry 3 to the next place, saying 7 times 4 make 28, and 3 make 31, which I set downe also, so I haue done with the 7, and cancell it, and begin with the 2, saying 2 times 3 make 6, which I set downe vnder the 2, and carry

|         |  |
|---------|--|
| 4563    |  |
| 327     |  |
| 31701   |  |
| 9126    |  |
| 13689   |  |
| 1491861 |  |

carry 1 to the next, saying 2 times 5 make 10, and 1 that I carryed make 11: whereof I set downe 1 and carry 1, and say 2 times 4 make 8 and 1 maketh it 9, which I set downe also, and so I haue done with the 2. Lastly, beginning with the 3 remaining, I say first, 3 times 3 make 9, which I set down right vnder the 3: And againe say 3 times 6 make 18, whereof I set down the 8 and carry the 1 to the next place where say 3 times 5 make 15, and 1 that I carryed make 16, whereof I set downe the 6 and carry 1 to the next, saying 3 times 4 make 12, and 1 that I carryed makes 13, and so I haue ended, onely adding the numbers vnder the line as you were shewed to do before in Addition, and you shall finde the Products will be 1491861: which hauing set downe, may be enclosed betweene 2 lines as the Operation requireth.

*Diuision.*

**T**O diuide is to search how many times one some is contained in another, as if I would know how often 234 were containd in 5382, Place the greater first, and the first of the lesse towards the right hand vnder the first of the greater, thus, making a crooked line for the Quotient: and then say how often I haue 2 in 5, say two times, which 2 set behind the crooked line, or Quotient, and there will remaine 1, Then say 2 times 3 make 6, which taken from 13, there will remaine 7, which set ouer the 3. Then say 2 times 4 makes 8, which take out of the 78 aboue it, and there will rest the 70, so putting out the 8 and the 234, you must remooue the 234 one place neerer to the right hand as aboue is seene, Saying how many times two can I haue in 7, say 3 times, and yet there will remaine 1, Set the 3 in the Quotient, and the 1 ouer the 7, and put out the 2 vnderneath. And then againe say 3 times 3 make 9, which taken from 10 ouer it, there will rest 1, which I set ouer the 0, and put out the 10 and the 3 vnder it. Lastly, I say three times 4 maketh 12, which being taken out of the 12, there will remaine nothing. Wherefore you finding 23 in the Quotient, or behind the crooked line, may conclude that 234 is 23 times contained in 5382, which was desired to be knowne. If any remainder had beene, it would haue made a Numeratour to the Diuifour, &c.

*To extract the Square roote.*

**T**O extract the true square roote (or the neereft that may be found) is to search out a nūber, that being once multiplyed in it selfe (with the remainder if any be) will produce the number assigned. As suppose it were required to finde the square roote of 4489, put vnder the 9 one pricke, and vnder the next 4 another pricke, thus leauing one figure betweene the two pricks, and so alwayes if there were more figures, and after take the square number or neereft thereunto of the number ouer the last pricke, namely of 44, which is the square 36, which taken from 44, there will remaine 8, which place aboue the pricked 4, and take the square roote of the 36, which is 6, then double the 6, and it maketh 12, which take as oft as you can out of 18, so as that the square of the second number to be produced, may also be extracted, and it will be found to be 7: which being multiplyed

plied by 12, will make 84, which taken from 88, there will remaine 4, which set about the 8, and multiply the 7 in it selfe, and that will produce 49: which taken from the 49 ouer it there will rest nothing, and so you shall finde 67 to be the square roote of 4489; for multiply 67 in it selfe, it will produce 4489.

*To extract the Cubicke roote.*

To extract the Cubicke roote of any number is to finde that number, that being multiplyed in it selfe, and the product againe by the same number, will make the number assigned (or the neereſt thereto if the number be not a Cubicke number.) So to extract the Cubicke number of 32768, place one pricke vnder the first figure 3, and another vnder the fourth figure 8, and so further if there be more to leaue two figures between each two prickes, and looke (as before for the square roote) how many prickes there be so made, so many figures there will be in the Quotient, and then seeke the Cubicke root (or the neereſt to it) vnto 32, which will be found to be 3, which 3 27 68 multiplyed in it selfe maketh 9, and that product againe multiplyed by 3, produceth 27 out of 32, subtracting 27, there will remaine 5, and that may be set ouer the 2, and the Quotient 3 also by it selfe. And then to finde the 2 figure of the Quotient, put down 3, and his square 9, & his Cube 27. Now we must take a new number in the Quotient, so that when the 27 shall be multiplyed by the same number, which is 3 and the 9 by the square of 3 which is 4, and againe the new number cubickely in it selfe, and placing the 3 products in order, as the operation here set downe sheweth, and the same Aggregate subtracted from the remainder of the diuision, that in this extraction there shall want nothing, so the Quotient will be found to be 32, which multiplyed cubickely will make his Cube 32768.

By the square roote all sorts of Battalions are framed thus. viz.

*To make a square Battallion of Men.*

**E**Xtract the square root of the number of men proposed, and it will yeeld the number both for Ranke and also for Fyle.

*To make a Battallion square of ground.*

Allow 3 foote in breadth, and 7 in length, which is the space that euery Souldier occupyeth marching, Multiply the number of men proposed by 3, and diuiding the products by 7, then extract the *square root* of the Quotient, and that will be the number of men for the Fyles. By which then diuiding the said number proposed, and the Quotient will be the number of men in Ranke.

*To make a Battallion whereof the Front shall be to the Flanke in any proportion given.*

Multiply the number of men proposed by the proportion appointed for the Flanke, and from the product extract the Square roote, which will bee the number of men for the Fyles or Flanke. And againe to finde the number



ber of men for the Front, Multiply the proposed number of men by the proportion assigned for the Front, and from the product thereof, extract the Square roote, which roote will be the number of men for Front.

*To make a doubled Batallion.*

Double the number of men propounded, and extract the square roote of that, and it will be the number of men in Front: Then halfe that number, and it will be the number of men for Flanke.

*To make a Batallion of a great Front.*

Diuide the number of men propounded by the number of men assigned for the Front, and the Quotient will be the number of men for the Flanke.

The *Batallions* square of men, or square of ground, are weake in Front, and those of great Front, are weake in Flanke.

The *Spaniards* most commonly vse the doubled *Batallia*.

And the *Hollanders* the great Front, for they vsually make their Flanke consist but of tenne Ranckes.

By the extraction of this Cubicke roote you may find the solid capacity of any Shot, Ordnence and such like solides: hereof we wil speake more hereafter in his place

*A Table shewing the Square roote unto 3844, and the Cubicke roote unto 238328. Calculated by the Author R. Norton.*

|     |    |       |      |    |        |
|-----|----|-------|------|----|--------|
| 1   | 1  | 1     | 1024 | 32 | 32768  |
| 4   | 2  | 8     | 1084 | 33 | 35772  |
| 9   | 3  | 27    | 1156 | 34 | 39304  |
| 16  | 4  | 64    | 1225 | 35 | 42875  |
| 25  | 5  | 125   | 1296 | 36 | 46656  |
| 36  | 6  | 216   | 1369 | 37 | 50653  |
| 49  | 7  | 343   | 1444 | 38 | 54872  |
| 64  | 8  | 512   | 1521 | 39 | 59319  |
| 81  | 9  | 729   | 1600 | 40 | 64000  |
| 100 | 10 | 1000  | 1681 | 41 | 68921  |
| 121 | 11 | 1331  | 1764 | 42 | 74088  |
| 144 | 12 | 1728  | 1849 | 43 | 81307  |
| 169 | 13 | 2197  | 1936 | 44 | 85184  |
| 196 | 14 | 2744  | 2025 | 45 | 87120  |
| 225 | 15 | 3375  | 2116 | 46 | 97336  |
| 256 | 16 | 4096  | 2209 | 47 | 103823 |
| 289 | 17 | 513   | 2304 | 48 | 110592 |
| 324 | 18 | 5832  | 2401 | 49 | 117649 |
| 361 | 19 | 6859  | 2500 | 50 | 125000 |
| 400 | 20 | 8000  | 2601 | 51 | 132651 |
| 441 | 21 | 9261  | 2704 | 52 | 140608 |
| 484 | 22 | 10648 | 2809 | 53 | 148877 |
| 529 | 23 | 11197 | 2916 | 54 | 156464 |
| 576 | 24 | 13824 | 3025 | 55 | 166375 |
| 625 | 25 | 15625 | 3136 | 56 | 175616 |
| 676 | 26 | 17576 | 3249 | 57 | 185193 |
| 729 | 27 | 19683 | 3364 | 58 | 195092 |
| 784 | 28 | 21952 | 3481 | 59 | 208179 |
| 841 | 29 | 24389 | 3600 | 60 | 216000 |
| 900 | 30 | 27000 | 3721 | 61 | 226981 |
| 961 | 31 | 29791 | 3844 | 62 | 238328 |

*To finde the Fractions Quantity, when the number giuen  
is not a square number.*

**V**Hen you haue extracted the Square roote of any number, and that yet there resteth something after the extraction made, that sheweth the number not to be a Square number, and being very difficult to finde the roote of a number, not square, exactly, but to come neere it: double the roote for denominator, and take the remainder for numerator. *Example*, I would finde the square roote of 10, the greatest Roote in 10 is 3, and 3 times 3 maketh 9, so the remainder is 1 for Numerator, and I double 6 for denominator. so the neereft square roote of 10 is  $3\frac{1}{6}$  which is  $\frac{1}{6}$ , part too little. But if I should adde 1 to the double of the Roote for denominator, and take the remainder for Numerator, that would make the roote of 10 to be  $3\frac{1}{4}$ , which is too much by  $\frac{1}{4}$ , part.

### Of Fractions.

*What a Fraction is, and to reduce Fractions.*

A Fraction is a part of a whole number, and the proportion thereof is to the whole number as the Numerator is to the Denominator of the same. And where the Numerators and Denominators are great numbers, they are to be reduced into their least denomination: which to doe, is to finde the greatest number that will diuide them both. As I would abreviate  $\frac{225}{300}$ , I finde 5 the number that is common to diuide them both, and thereby I first diuide 225, and thereof commeth 45 for numerator, then I diuide 30 by 5, and that produceth 60. I say then  $\frac{45}{60}$  valueth as much as  $\frac{225}{300}$ . But to finde the smallest fraction, take 225 out of 300, and there will rest 75, and then I take 75 out of 225, and there rest 150: then I take 75 out of 150, and there rest 75, which is the number I seeke, whereby I first diuide 225, and the Quotient will be 3, then I diuide 300 by 75, and the quotient will be 4, so  $\frac{3}{4}$  and  $\frac{1}{5}$  and  $\frac{1}{6}$ , are of one and the same value equall amongst themselues, and one to another. And so you may doe with any other fraction to reduce it to the last denomination.

Againe, some fractions cannot be abreviated, as  $\frac{1}{2}$ , out of such a fraction take 2 or 3 vnities from the Numerator, that is, take  $\frac{1}{2}$  from  $\frac{1}{2}$ , and there will rest  $\frac{1}{2}$ , and reduce the  $\frac{1}{2}$  to  $\frac{1}{2}$ , so  $\frac{1}{2}$ , and  $\frac{1}{2}$  is equall in value  $\frac{1}{2}$ .

To reduce many diuers Fractions into one denomination, There can but two of them bee reduced at once, as I would reduce  $\frac{1}{2}$  and  $\frac{1}{3}$  into one denomination I set them thus,  $\frac{1}{2}$ : And multiply the two denominators together, and they make 48, which shall be the denominator, then I multiply 6, the first denominator by 4 the second numerator, and thereof commeth 24 which I set apart for the first, then I multiply 8, the second denominator by 5, the first Numerator which produceth 40, which I also set apart for the second Numerator, each set ouer the denominator 48, will be

be so reduced to  $\frac{2}{3}$  and  $\frac{4}{3}$  or  $\frac{1}{3}$  or 1 and  $\frac{2}{3}$  equall to  $\frac{1}{3}$  and  $\frac{1}{3}$ .

*Addition of Fractions.*

But if all the Denominators be a like, adde all the Denominators together, and set their common Denominator vnder the sums of them, as  $\frac{1}{2} + \frac{1}{2}$  make  $\frac{2}{2}$ , or 1  $\frac{1}{2}$ .

*Substraction of Fractions.*

To substra<sup>t</sup> one Fraction from an other, first (if they be not) reduce them to one Denomination, as to take  $\frac{1}{2}$  from  $\frac{3}{2}$  which reduced, make  $\frac{1}{2}$  for  $\frac{1}{2}$  and  $\frac{3}{2}$  for  $\frac{3}{2}$ , then substra<sup>t</sup>  $\frac{1}{2}$  from  $\frac{3}{2}$ , rests  $\frac{2}{2}$ , the remainder sought.

*Multiplication of Fractions.*

To Multiply Fractions, you must Multiply the Numerators together for a new Numerator, and also the 2 Denominators together for a new Denominator, as  $\frac{1}{2}$  by  $\frac{1}{2}$  produce  $\frac{1}{4}$  or  $\frac{1}{4}$ , or  $\frac{1}{4}$ , or  $\frac{1}{4}$ .

*Diuision of Fractions.*

To diuide Fractions one by an other the easiest way, is to make one of the Denominators to stand as Numerator, and the Numerator thereof as Denominator, and then to worke as you did in Multiplication of Fractions: As I would Diuide  $\frac{1}{2}$  by  $\frac{1}{3}$ , I changing one, they stand thus  $\frac{1}{3}$  and  $\frac{1}{2}$  and say 3 times 3 make 9, and that 4 is Numerator for the Quotient, and 4 times two makes 8 for Denominator thereof: So  $\frac{1}{2}$  Diuided by  $\frac{1}{3}$  make  $\frac{3}{2}$  the Quotient sought.

Definitions.

Geometry is the Art to measure well, and is the  
Sinewes of the Art of Artillerie.

Geometry hath her Originall from *Poynts, rights, crooked lines, right and oblique Angles, Superficies, and Bodies, &c.*

A *Poynt* is a thing that cannot be diuided as *A*.

A *Line* is a thing that hath *Length* without *breadth*, & serueth for lengths, breadths, heights, and depthes, as *B*.

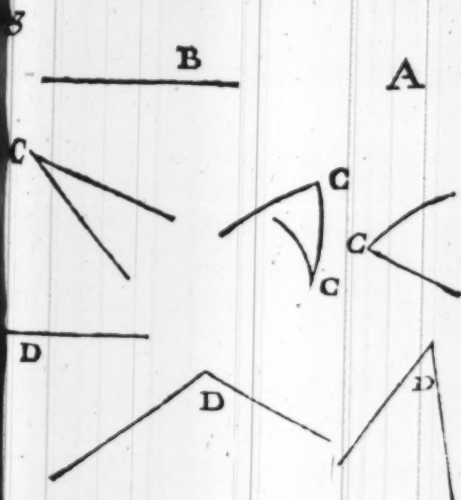
An *Angle* is the meeting of two lines, so as they make not one line, and are either right lined Sphæricall, or mixt Angles, as *C*.

And an *Angle* is a right angle, a blunt, or a sharpe *Angle*.

An angle greater then a right angle, is a blunt or obtuse angle, as *D*.

An angle lesser then a right angle, is a sharpe or acute angle, as *E*.

A *superficies* is that which hath on-  
ly





ly *Length* and *Breadth*, as a *Quadrat* or *Triangle*, &c. as E. E.

A *Body* is that which hath *length* and *breadth*, and also *thicknesse* as a *Cube*, &c. F.

A *Tryangle* is a superficies, made onely with three lines, and is either *right lined*, or *Sphæricall*, as G.

A *Quadrat* or *square* is a superficies quadranguled, made of foure lines, as H.

A *Circle* is a plane Figure, contained vnder one line, which is called the *circumference* thereof, as I.

A *Centre* of a *Circle* is a point in the midst thereof, from which all right lines drawne to the circumference, are equall, as I. also

A *Trapezia*, is a right lyned figure of foure vnequall sides, as K.

The especiall things belonging to a *Gunner*, being *Arithmetick* (which we haue heerein briefly touched) and *Geometry* which wee now purpose to point at, and *Perspectiue* whereof hereafter a word for taking distances: And of each of them in as bricfe manner as I can, because they are not by necessity to be accounted any reall parts of this Art and Practise of Artillery, but only necessary apendants thereto: For it is necessary that the *Gunner* should know what a line, a superficies, and a body is, and how to measure each of them, as well the right as the crooked, the leuell Hypothenusall & perpendicular & diametral lines, and the Angles they can make right or obliques. And measure the *Triangles*, *Squares*, and *Circles*, the *Globes*, *Columnes*, and *Cillinders*: And in effect to carrie in his memory these *Definitions*, *Demands*, and *Common sentences*, of *Euclids Elements*: and especially the first *Proposition* of the same which teacheth.

### How to make an *Equilaterall Triangle*.

EVCLID. I. PROPO. I.

Which is, *Vpon the given right line Ab, to make the Equilaterall Triangle abc.*

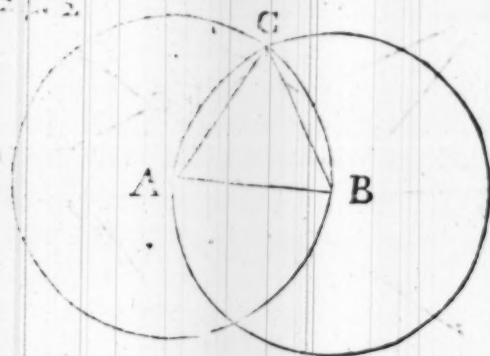
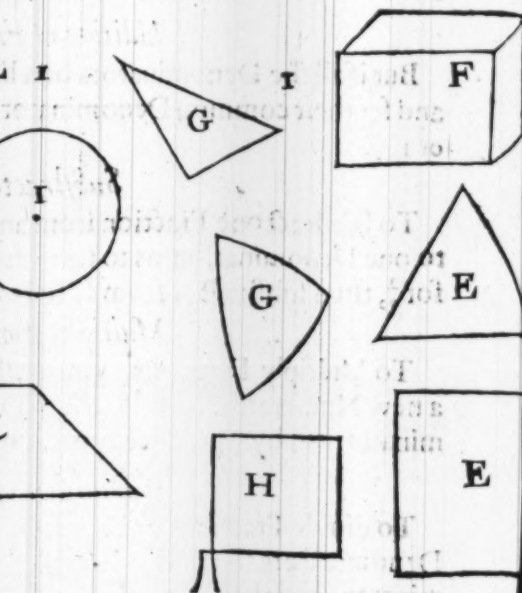
With the distance *ab*, vpon *a* and *b* describe two circles, the intersection *C* ioyned with *a* and *b*, shall make the Equilater tryangle *abc* required.

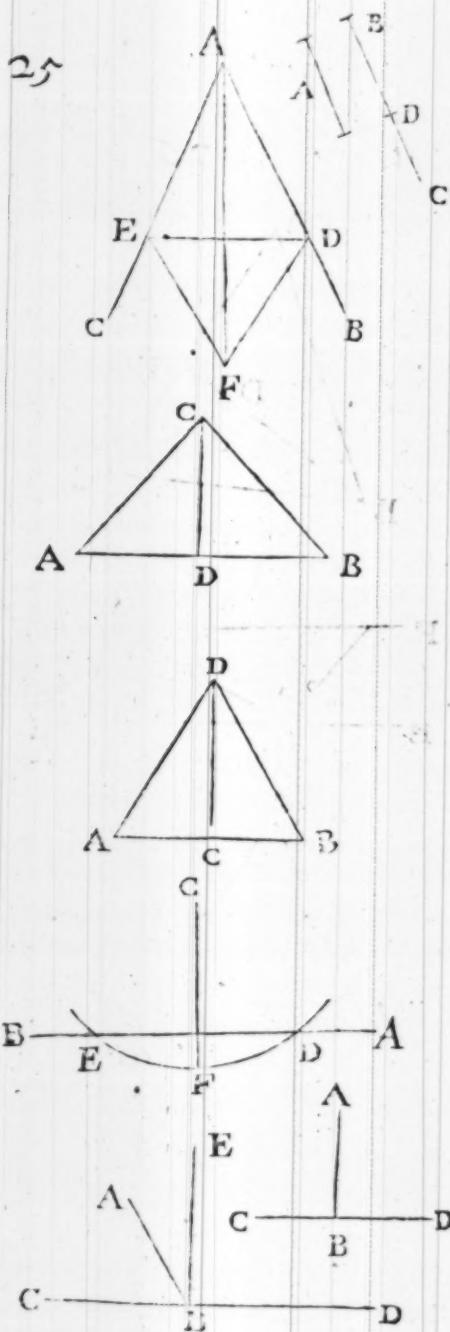
\* 1. Dem. 1. \* ioyned with *a* and *b*, shall make the

And then the 3. PRO. I.

*Two vnequall right lines being given, to cut from the greater a right line equall to the lesser.*

From the Centre *B*, with the distance





Let cut  $CB$  in  $D$ , so will  $BD$  be equal to  $AD$ .

\* 2. I.  
15. Def. 1.

And the 9. PROPO. I.  
To divide an angle given by a right line in the middle, or into two equal parts.

To halfe the given Angle  $bac$ , with a right line.

From  $a$  cut  $ad$  at pleasure, and also  $ae$  equal therunto, and draw the right line  $DE$ , and make the Equilateral triangle  $DEF$ , and ioyn  $AF$ , which will halfe the given angle.

\* 3. I.

\* 1. I.

And the 10. PROPO. I.

To halfe a given right line as  $AB$ .

Vpon the right line  $AB$ , make the Tryangle  $ACB$ , the angle  $C$  halfed.

\* 1. I.

\* 9. I.

And the 11. PROPO. I.

To raise a perpendicular line  $CF$  vpon a right line  $ED$  from a point  $C$  therein giuen.

Vpon the point  $C$  set the Compasses, and on each side thereof in the line  $ED$  take equal distances at pleasure, and vpon them make an equilateral Tryangle  $DEF$ , and then draw the line  $FC$  which shall be perpendicular to  $ED$  vpon the point  $C$ .

\* 1. I.

And the 12. PROPO. I.

Vpon an infinite right line  $ab$  giuen, from a point  $C$  without the same, to let fall a perpendicular right line  $CF$ .

Vpon the Centre  $C$  the Arch of a circle described, will cut the right line  $AB$  in  $D$  and  $E$ , diuide  $DE$  into halfe at  $F$ , ioyn  $C$  to  $F$ , and so  $CF$  will be perpendicularly let fall at  $F$  vpon  $AB$ .

\* 10. I.

And the 13. PROPO. I.

A right line  $ab$  falling vpon another right line  $cd$ , maketh either two right angles, or else angles equal to two right angles.

In the perpendicularity of  $EB$  to  $CD$ , it is sufficiently manifest; but if  $AB$  be not perpendicular in the poynt  $B$  erect the perpendicular  $EB$ : so we see the angle  $ABC$  and the angle  $ABD$  taken together, to occupie the place of

\* 11. I.

the two right angles  $EBC$  and  $EBD$ .

And the 21. PROPO. I.

If within a Triangle  $abc$  in the side  $bc$ , from the extreames of two right lines  $bd$  and  $cd$ , they are lesse then the sides  $AB$  and  $AC$ , but the angle  $D$  that subtends it, will be greater then the angle  $A$ .

Continue out the side  $BD$  to  $E$  in the tryangle  $BAE$ , the sides  $BA$ ,  $AE$  taken together, are greater then the third  $BE$ , and  $D$  is therefore greater then  $A$ .

And the 31. PROPO. I.

By a point given  $A$  to the given right line  $BE$  to draw a right line paralell.

\* 23. I. Draw  $AD$  that it make the alterne angle  $ADC$  equall to  $DAF$ , and continue  $FA$  to  $E$ , and the Alternates being equalls, the lines must be paralell.

\* 29. I.

And the 32. PROPO. I.

Every Triangle as  $ACB$  with one side produced  $AB$  to  $D$ , The externall angle  $CBD$ , will be equall to the 2 internall opposite Angles  $A$  and  $E$ , the three angles of a Tryangle being equall to two right angles.

\* 31. I. To the side  $AC$  make the paralell line by the point  $B$  namely  $BE$  in these two paralells  $AC$  and  $BE$ , the line of incidence  $CB$  maketh  $CBE$  equall to  $EBD$ , and  $B$  equall to  $A$ : so the whole externe angle is equall to the two interne angles, to which let the third  $CBA$  the common angle, and the three angles of the Triangle equall to two right angles.

\* 13. I.

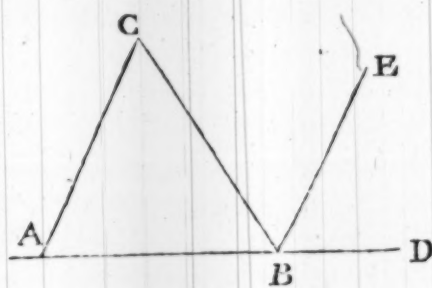
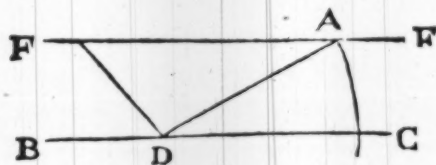
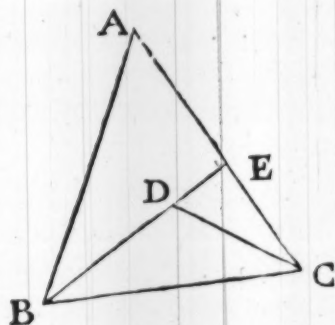
And the 46. PROPO. I.

Upon a right line  $AB$  given to make the square of equall sides, and equall angles  $ABCD$ .

From either extreame as  $A$  of the given line, let the perpendicular line  $AD$  be erected equall to the given line, and by  $D$  make to  $AB$  paralell and equall the line  $DC$ , ioyne  $C$  and  $B$  equall, and paralell  $ADCB$  ioyning  $DA$  and  $CB$ , they will be equall. And

\* Axiom. I. the Parallelogram made equilaterall, and

26





and because the Angles  $C$  and  $B$  opposite to the right angles  $A$  and  $D$ , it is a rectangle and  $\therefore$  a square.

\* 30. 1.

And the 47. PROPO. 1.

In the rectangled Triangle  $ABC$ , the square that is made of the side  $AC$ , subtended by the right angle  $ABC$  being described, will be equall to the Squares  $ABED$  and  $BCGF$ , which are described of the sides containing the rectangle.

Let the three Squares  $AH$ ,  $AE$ , and  $CF$  be described, and in a direct line let  $AB$ ,  $BF$ , and  $CB$ ,  $BF$  lye, and draw  $BL$  paralell to  $AI$ , and draw also  $BH$ ,  $BI$ ,  $AG$ , and  $CD$ .

The common angle  $ABC$  being added to the rectangles  $DAB$  and  $IAC$ , are  $\therefore$  equall to the Angles  $IAB$  and  $DAC$ ,  $\therefore$  and also to the tryangles, \* 2. Axiom. \* 4. 1.

And the 5 PROPO. 4.

About a Tryangle to describe a circle.

Divide any two of the sides into the  $\therefore$  midst by perpendicular lines meeting in  $F$ , from whence draw a right line to each angle, and by their distance describe the circle,  $FA$ ,  $FB$ , and  $FC$ , will be  $\therefore$  equall, and vpon the  $\therefore$  centre  $B$  a circle is described about the tryangle.

\* 10. 1.

\* 4. 1.

\* 9. 3.

1.  $\therefore$  If the centre fall in the side the tryangle is rectangled if within Acute, if without obtuse angled.

\* 31. 3.

2. By three points not being in a right line to describe a circle by this proportion, for ioyn the 3 poynts and you haue a Tryangle.

And the Corolaries and the Scholion thereof, viz.

To euery regular figure that is equilaterall and equiangled, a circle may be as well  $\therefore$  inscribed by the distance of the perpendicular, as subscribed with the distance to the Angles, and those cut in halfe.

\* 4.

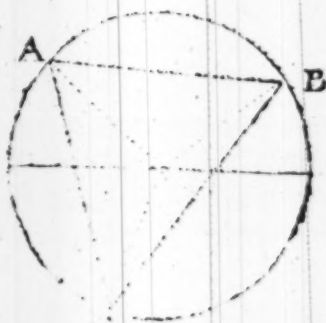
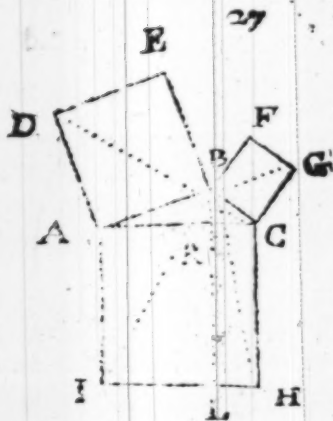
\* 6. 1.

And the 10 PROPO. 4.

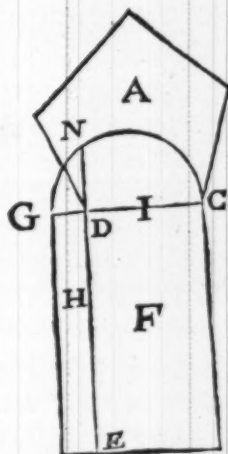
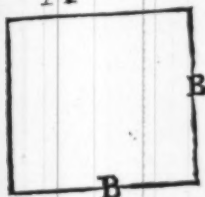
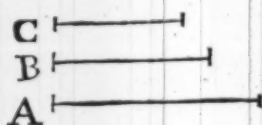
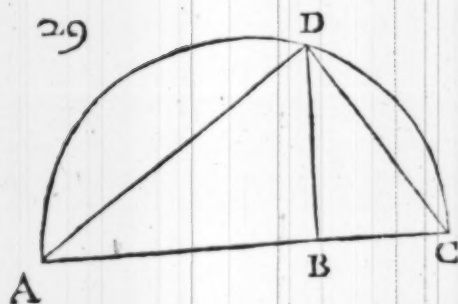
To make an isosceles Tryangle that may haue either of the angles at the Base double to the rest.

Any  $\therefore$  giuen line as  $AB$ , that the rectangle

\* 11. 21.







set AD, the third giuen line draw together DB, and by C draw the <sup>\*</sup> Parellell thereunto CE, so it will be as <sup>\*</sup> AB the first, to BC the second, so will AD the third be to CE the fourth sought.

And the 13 PROPO. 6.

Two right lines AB, BC, being giuen to finde a meane proportionall betwene them.

Set the two right lines giuen in one direct line as AB, BC, vpon all that line AC, describe the semicircle ADC, and from B <sup>\*</sup> raise the perpendicular line BD, and draw AD, CD: therefore ADC is a right angle (being in a semicircle) and BD the perpendicular maketh two triangles ABD and CBD <sup>\*</sup> equiangled, and therefore proportionall: Therefore BD is the meane proportionall.

And the 17 PROPO. 6.

If three right lines be proportionall, as A to B, so B to C, then that rectangle that is made of the extremes A and C, shall be equal to that which is made of the Meane B.

Because the meane proportionall B is twice put, it will bee as in the 16. Pro. that 4 right lines about 4 right equall angles, are <sup>\*</sup> reciprocally proportionalls, Therefore rectangled <sup>\*</sup> and equall: and contrariwise being equally rectangled about right angles, they haue their sides reciprocally proportionalls, viz. as A to B, so is the same B to C, which was to be shewed.

And the 25 PROPO. 6.

Any right lined figure giuen a like, and in like sort placed, to make another equall to the giuen.

Let A be the right lined figure giuen, a like vnto which is to bee made. To the side DC at angle CDE, let the <sup>\*</sup> parallelogram F equall to it bee applied: Againe to the side of this DE there may be applyed contiguous to EDG, the Parallelogram u equall to a right lined figure B, vnto which it is to bee constructed

<sup>\*</sup> 31. 1.  
<sup>\*</sup> 2. 6.

<sup>\*</sup> 11. 1.

<sup>\*</sup> 8. 6.

1. Def. 6.  
14. 6.

<sup>\*</sup> 44. 45. 1.

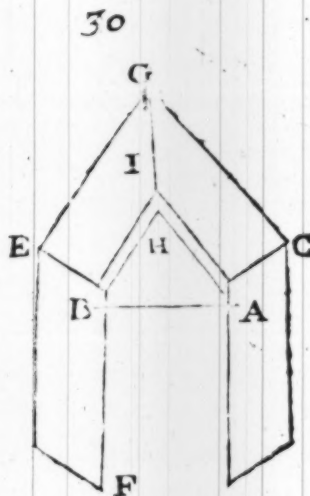


- \* 13. 5 constructed equally between CD and DG \* seeke the meane proportionall DN or IK: vpon which the right lined figure A is to bee made equall to B. Wherefore seeing it is as the first CD, is to the third DG, so is F to H, that is  $\angle$  to B, and  $\angle$  to L, and also L is equall to \* B made like to  $\angle$  which was to be done.

\* 22. 5 And lastly the 14. PROPO. II.

*Towbat planes soeuer ED and EF, the same right line figure A B is right they are parallels,*

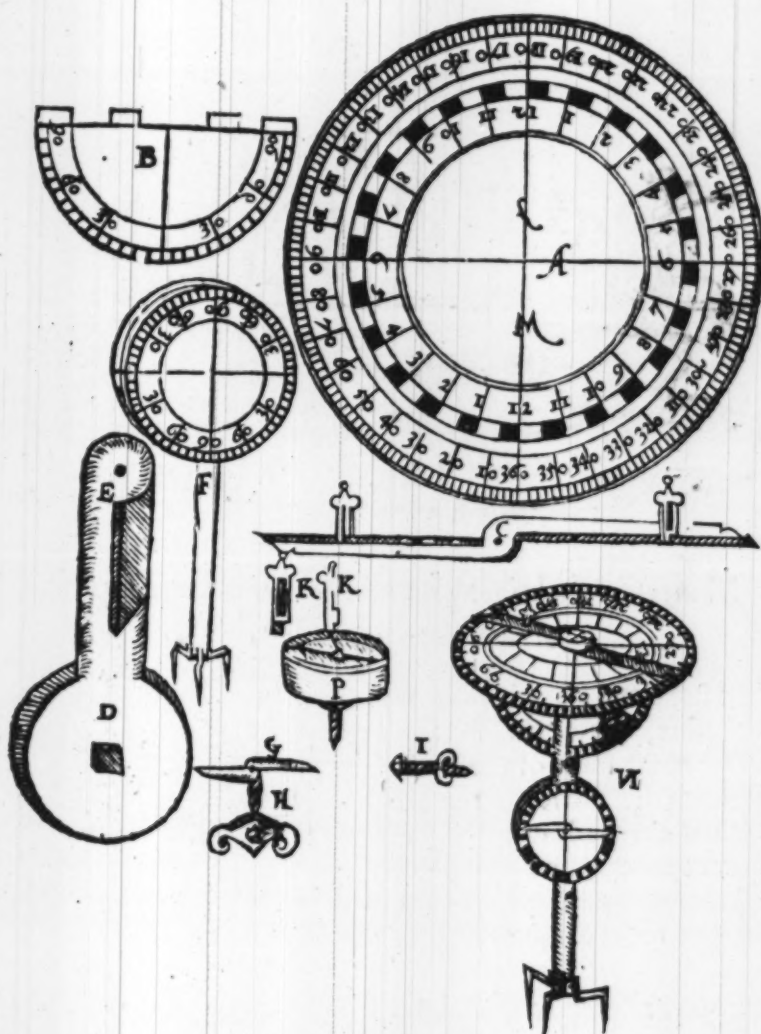
- If they be not Parallels being produced, they will concur to the parts C, E, and \* make the Section GH a right line, in which any where take the point I, and draw I A, I B in the planes GCD and GEF. And so when as A B is placed right to either, it will bee the plane of the Triangle A I B, the angles L A B and I A B would be right, which are neuerthelesse \* lesser then right angles.
- \* 3. 11.
- \* 17. 1.



*To measure inaccessible Heights, Breadths and Distances, and take a play by my Cosmodelite with the description thereof.*

Vpon the semicircle vnder the Cosmodelyte there are two squares Geometricall, each side of them being diuided into 120 equall parts, and vpon the Centre of that Semicircle a Rule or Index with the two sights ouer, or parallell vnto the fiduciall edge thereof. As suppose I were to measure the distance from me to a Tree, to doe which, place the Semicircle, so that the Index layd vpon the Dyameterrall line may direct with the sight to the tree or marke, then laying the Index vpon the Semidiametre that is perpendicular to the Dyameterrall line, and choose some marke of competent distance whereunto the sights direct, or els measure 20 or 100 yards, paces, or feet in that line, and there set a marke, and then leauing a marke where you first stood, remone your instrument thither, and by the Semidiameterrall line looking backe to the first station or marke, thereby you may place the Semicircle in the first position; which done, turne the Index vnto the Tree or Marke. whose distance you are to measure. and see what number of those 120 parts it cutteth, then, say by the Rule of 3, If 120 all the parts, the parts cut, as suppose it were 80. What shall 300 yards which I imagine was measured betwene the first and second Stations giue, multiplying the third

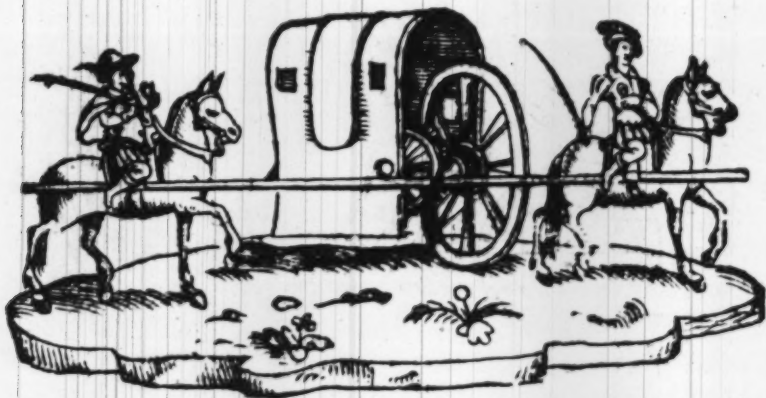
third number 300 by 80, the second number produceth 8000, which diu-  
ding by 120, the first number yeeldeth 66 yards, the distance so  
right.



*To measure the breadth of a Breach.*

**L**ay on the Index vpon the Dyametral line, and turne that to one side of  
the Breach, and the instrument remaining in that position, note the num-  
ber the Index will cut when it is turned with his sights to respect the other  
side of the Breach, then goe forwards or backwards vntill you see the last  
side of the breach by some other number of parts (letting a conuenient di-  
stance betweene the Stations) and noting the difference of those parts, and  
the distance of the Stations measured, suppose, 50 yards and the difference  
of parts to 20. Say by the rule of three, if 120, all the parts giue 20, the parts  
cut by aspect of the Index, what shall 50 yards giue, multiplying 70 by 50

produceth 3500 : which diuiding by 120, yeeldeth 29 yards, and  $\frac{2}{3}$  parts of a yard, the breadth of the Breach sought. A height is taken in the same manner, onely reuerſing the Plane of the Instrument perpendicular, which before did lye Horizontally, imitating the reſt of the worke as aforeſaid.



*To meaſure the height of any Tower, or other thing by the ſhadow it maketh, the Sun ſhining.*

**T**AKE a ſtaffe and place it perpendicularly neere the ſhadow you deſire to meaſure, marke the two ſhadowes of the Tower and of the Staſſe, then ſuch as the ſhadow of the Staſſe hath proportion to the ſtaffe, ſuch hath the ſhadow of the Tower to the Towers height. Example. Let vs ſuppoſe the length of the ſhadow of the ſtaffe to be 12 hand-breadths, and the ſhadow of the Tower to be 45 foote; the ſtaffe was 8 hand breadths. Then ſay by the Rule of proportion: if 12 giue 8, what ſhall 45 giue : worke and ye ſhall haue 30 foote for the height of the Tower ſought.

*To meaſure the height of a Tower by a looking-glaſſe, or the ſhadow thereof in a puddle of water.*

**S**UPPOſE there is a Tree or Tower whoſe height we deſire to know: Take a flat Mirror, or Looking-glaſſe, and lay it leuell or Horizontally vpon the ground ſome diſtance from the Tree or Tower, and then goe backwards vntill in beholding in the Glaſſe you thereby ſee the top of the Tree or Tower; your diſtance from the glaſſe hath proportion to the height of your eye, ſuch as the diſtance from the glaſſe vnto the poynt right vnder the top of the Tree or Tower, is to the height of the ſaid Tree or Tower. As for example, ſuppoſe the diſtance betweene the Glaſſe and the Tower were 48 foote, and the diſtance betweene you and the Glaſſe be 4 foote, and the height of your eye above the leuell of the glaſſe to be 6 foote, ſay, if 4 giue 6, what will 48 giue, multiplying 48 by 6, produceth 288: which diuide by 4 giueat in the Quotient 72 for the height of the Tree, or Tower ſought.



To finde any distance, height, or breadth by resolving the Triangle made by Stations and Markes.

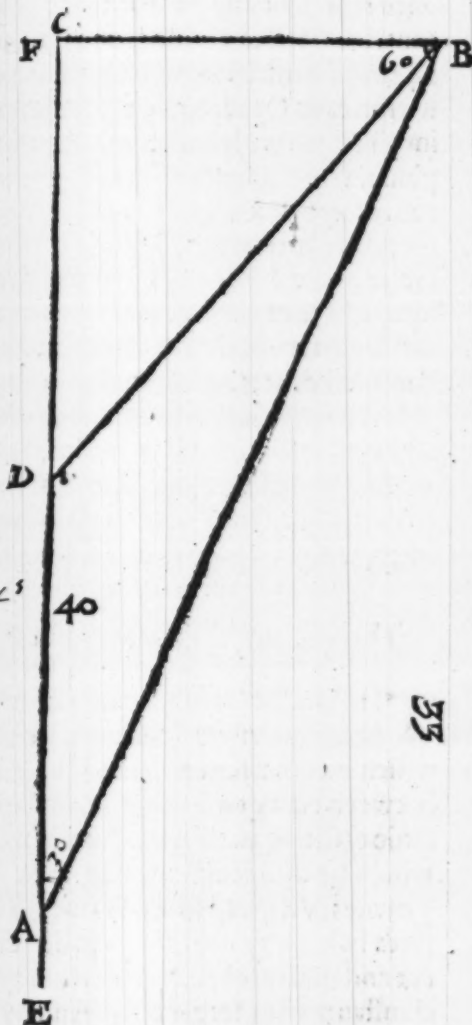
**T**O finde the vnkowne sides and angles, any 3 of these sides and angles being giuen, so one bee a syde, to finde the rest by Addition and Substraction. By the Table of Logarithmes remembering this Theoreme, That the Sydes in all plane Triangles are in proportion one to another, as the Synes of the Angles they subtend. *Example.*

Suppose that  $B, C$ , in the Triangle,  $A, B, C$ , be the height of a Tower, and let it be required to finde the measure thereof, and of the Hypothenusall lyne  $AB$ . First measure the distance from  $A$  to  $C$  supposed 40 paces, then by the Cosmodelite or other instrument planted at  $A$ , take the quantity of the angle  $BAC$  30 degrees, then by consequent the angle  $ABC$  will be the complement thereof 60 degrees (the angle at  $C$  being a right angle) and all the sides of a right line triangle being equall to two right angles, so there is already had 4 of the 6; namely, the 3 angles and the syde  $AC$ . Then finding the Logarithmes of the Angles. As for the Angle sixtie degrees, and for the angle 30 degrees, and for the rectangle  $C$  90 degrees. Then say by the Rule of proportion, if  $AC$  the syne of the Angle  $ABC$  giue  $BC$  the syne of the angle  $BAC$ , what giues  $AC$  40 paces, and the Logarithme of  $AC$  to the Log of  $BC$ , and thence subtract the Logarithme of  $ABC$ , and the Log: of the syne remaining will be  $23\frac{1}{2}$ ; for  $BC$  sought.

And for  $AB$ , the Hypothenusall say, if  $AC$  giue  $AB$ , what will  $AC$  40 paces giue *facit*,  $46\frac{1}{2}$  fere.

The like may be done for all distances and breadths whatsoeuer.

Thus much shall suffice for the appendants. Now to the principall matter it selfe.



*The Description of the Horse-litter, and the Cosmodelite, and to  
Delineate by eyther of them any Champion assigned.*

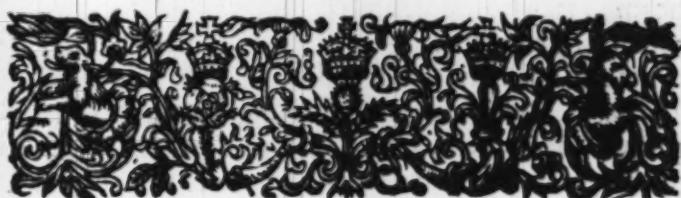
**T**HIS Instrument, the *Cosmodelite* is so plainly demonstrated to the Eye by the Figure thereof, that it needeth few words for further description; Only, you may perceiue it to haue so many seuerall bendings, that it may at once represent any two or three planes assigned: It consisting of two concentrick Circles diuided, one into 360 equall parts as at *A*: The other into 24. and a semicircle, each Quadrant diuided into 90 equall degrees as *B*: and within each Quadrant is a geometricall Square, each side thereof diuided into 120 parts; It hath an Index with sightes, as *C* playing vpon a Center-pinne, vnder a boxe with a Magneticall Needle therein as *P*: Vpon the bottom of the Boxe is pasted a Chart of the 32 Poynts, and a Limbe of 360 degrees: It hath also a Circle with Ioynts at the knee, with an Index as *F*, to inclyne or recline the Instrument to any Angle assigned, the Cheekes, the square hole of the halfe slits between *D* and *E* being the Index & mouing of the supporters of the said Semicircle & circle *B* and *A* as its and altogether considered, are represented at *N* to the eye very apparantly.

It is an excellent and generall Instrument, if it be well made, vnderstood, and vsed as it ought to be: This shall suffice, with the former Figure in the 31 for the Description, and some vses thereof; Only a word or two, how to describe a Champion in plaine by it, and a whole Region by the Horse-litter, whose Figure is also in the 32 Page hereof shewed.

*To make and Deliniate in Platte any Champion, or Region assigned.*

**T**HE Horse-litter traueling of purpose, with the motion of the Wheele hanged in Steele Springs, roaling on the way, The other Wheels which it turneth, giueth the Measures of Paces, Yeards, or Feete, conteyned between euery two angles, and the Compasse within, deliuereth to the Obseruor (sitting within the Litter) the alteration of angles from time to time, which he dilligently noting in a Booke, with all obseruable things, as Townes, Vilages, Hilles, Woods, Riuers, Valleys, Parkes, Wastes and Inclosures in his way notable, to protract by the degrees of the Needle, or poynts cut and measures found betweene angle and angle, with the obseruable Circumstances not forgotten; And by the *Cosmodelites* Index and Needle noting the degree cut, it respecting each obseruable Marke, at the first, second, third station, &c. If need be of so many noted, and the distance of each station from other being measured with a Chayne, Lyne, or two Poles, or such like, in knowne Measures also protracted, the true Platte of a whole Region, Mannor, Champion or Field, may be easily Described, by practizing duly what hath been already said, & all Distances, Heights, Breadths, & Profundities accessible or inaccessible also measured: As Master *Diggs* in his *Panometria*, and Master *Ratborne* in his third Booke of the *Surveyor* haue largely (with variety) described, which with great ease, the dilligent Practician may well apply to eyther of these Instruments, which let suffice.

THE



THE  
PRACTISE OF  
ARTILLERIE.

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CHAP. I.

*Of the generall definition and distinguishing of Ordnance  
and Artillerie.*



Artillery generally taken, comprehendeth all manner of artificiall Engines for the Wars, diuised or vsed at any time, eyther to hurle Stones or Darts, or to shoote Arrowes or Bullets, or such like things, to, or at any remote Object; and that with greater violence and more certain direction, then by the naturall strength of any one mans hand can possibly bee otherwise performed: Whereby it appeareth also, that *Artillerie* differeth from all other Engins. First, for that all other Engins exercise their violence eyther vpon Objects at hand, or such as are eyther neere ioyned vnto themselues, without whose presence or contingencie they effect nothing at all: whereas *Artillerie* exerciseth her force and violence vpon things farre off, euen when the Object is not present or neere it. Secondly, in the exercise of other engins, the speciall thing required is strength and labour, rather then any great Art or Skill. Whereas in the vse and exercise of Artillerie, the principall thing required is Art and Skill how to direct and bend the same vnto the assigned seruice: without which they doe altogether worke in vaine. Thirdly, the proper vse of other engins, is either to draw some thing vnto them as, Capstaynes doe; to thrust or to remooue some thing from them, as Skrewes; to heaue vp, as Pumps and Pulleyes; or to presse downe, as Presses, &c. which most commonly serue at home for priuate vses, whereas *Artillerie* serueth to shoote and cast forth Bullets, Balles, Arrowes, Darts, Stones, and diuers sorts of Shot, seruing for the publike warres both at home and abroad, aswell defensiuely to repulse and destroy the assaulting Enemy, as offensiuely to spoyle, kill, annoy, beat and weaken the Common Aduersary in his Towns, Forts, Armies, Fleets,



Fleetes, Shippes, Ports, Subiects and designs. Artillerie therefore according to the times may be diuided into two sorts: namely, Ancient and Moderne. Each of which according to Magnitude may be againe subdiuided into two sorts also; namely, Great and Small. The Antient Great Artillerie were the *Catapult*, *Balista*, *Scorpion* and *Ram*, The Antient small Artillerie, the Long-bow, Crosse-bow, Sling, & Slurre-bow. The Moderne great Artillerie are the great Ordnance, being the principall Subiect both of this and the former Treatise, which in their places are at large particularly described, & distinguished; herein the small moderne Artillery are, the Long-bow and the Hand-gunnes. As the Harquebuse, Musket, Caliuier, Carbyne, Petronell and Pistoll, the particular vses of them as they appertaine, not necessarily to the Gunners Office to mannage or practise, being no way exacted from any accounted within the compasse of the *Traine of Artillerie*: So I therefore forbear to say much of them referring their Practises and Postures to the iudicious instructions of Valiant and Worthy Gentlemen, who haue delighted in the profession, vse, and practise of those Armes. For the Long-bow, although it be now growne somewhat out of warlike vse, since the inuention of small gunnes, yet bowes and arrowes being both ancient and generall warlike instruments, and were of two sorts, viz. the Long-bow and the Crosse-bow. The Long-bow is so wel known that it needeth no description: which doubtlesse of the two it was first inuented and practised in the Warres, as being the more simple Engine of the twaine, whose antiquity is surely very great, and seemeth to haue beene before *Noahs Flood*: For Almighty God promising to *Noah* and his sonnes, that hee would no more destroy all flesh with the waters of a flood, he giueth the *Rainebow* for a sure token thereof, which hee there called his Bowe, distinguishing the same from mens bowes, as things then familiarly knowne to *Noah* and his sonnes. And as it is ancient, so it is also of great force, by reason that all things therein almost doe worke *secundum naturam*. For first the Naturall and proper worke of the Chords, sinewes and ligaments of Mans arme are to draw and pull vnto it selfe, rather then to relate themselues to thrust off. Secondly, the matter whereof the Bow is made, be it of wood or Steele, by nature stiffe and starke, being bent with the string and drawne compasse with the arme, whilst it flyeth out to the straightnes which it naturally hath, and so fulfilleth his naturall worke. Thirdly, the Arrow artificially made, and proportioned to the strength of the Bow easily hangerh in the ayre, and swiftly and gently slideth through the same. The generall vse of it in all warlike nations may appeare, That the bow was in speciall vse among the *Hebrewes*. Many places of Scripture verifie, and the place of their seruice was in the Front of the battle; and amongst the *Philistims*, for *Saul* was sore wounded with the shooters of the *Philistims*. And amongst the *Egyptians*, king *Iosias* was hurt with the shooters of *Pharo Necho* king of *Egypt*: & amongst the *Assyrians*, *Achas* was slain with one of their arrowes: amongst the Citizens of *Rabbah* the *Amonites* their shooters shot from their walls against the army of *Ioab*: amongst the men of *Cedar*, *Arabians* and *Ismaelites*, whose strong archers God threatneth should be fewer. Amongst the *Lidians* whom God calleth forth with their Bowes against the disobedient children of *Iuda*: amongst the *Assyrians*; *Holophernes* hauing in his army 12000 archers on horse

Mach 9.11.  
Tit. Liv. lib. 7.

Chron 25.23.

24.  
Esay 21.17.

Ierem. 46.9.

Iudeth 2.15.

backe. And to bee short, if wee shall reade the ancient Histories of the Greekes and Romanes we shall finde the bow and arrowes every where so vsuall a weapon, that most nations haue continually vsed them: amongst whom our English Nation hath bene equall to the best, as all Christendome can beare vs witnesse in many battles; especially that which our Nation did for *Ferdinand* king of *Castille* vnder the leading of the Earle of *Bedford*, who with 10000 English bow-men, armed besides their bowes and arrowes, with battell-axes that hang at their backes, whereby he obtained so great a victory, that he & his successors haue euer since carried the sheafes of arrowes, and the long-bow in their shield, and also on their coyned halfe Royalls.

The second sort of Bowes is the Crosse-bow, which *Titus Linius* calleth *Scorpionius modicum*, partly by reason it hath the likenesse of that beast when the arrow is placed therein, and partly by reason of the like manner of hurting, watching all occasions when and where to strike surest.

CHAP. II.

Wherein is discoursed who were the Inuentors of Gunnes  
and Gunne-powder.



Having vndertaken in the former booke, called the Art of Great Artillerie, to shew by *Definitions*, *Theoremes*, and certaine *Questions*, the *Speculative* part of the Art of a *Canonier*, I haue now also thought fit in the second part by the rule of reason to demonstrate the Practicke part thereof, and to describe all sorts of Ordnance, as well such as are, and haue bene vsed in forreigne Nations, as those that are founded in England, and both the ancient and the moderne of both: wherefore I hold it needfull for compiling of the whole worke as compleate as I can, to declare by whom, and how this so diuellish an inuention was first brought to light. *Vffano* reporteth, that the inuention and vse as well of Ordnance as of Gunne-powder, was in the 85 yeere of our Lord, made knowne and practized in the great and ingenious Kingdome of *China*, and that in the *Maratyn* Prouinces thereof, there yet remaine certaine Peeces of Ordnance, both of *Iron* and *Brasse*, with the memory of their yeares of Foundings ingraued vpon them, and the Armes of King *Vitey* who he saith was their inuentour. And it well appeareth also in ancient and credible Histories, that the sayd King *Vitey* was a great Enchanter and Nigromancer, who one time (beeing vexed with cruell warres by the *Tartarians*.) coniuered an euill spirit that shewed him the vse and making of Gunnes and Powder: the which hee put in Warlike practise in the Realme of *Pegu*, and in the conquest of the *East-Indies*, and thereby quieted the *Tartars*. The same being confirmed by certaine *Portingales* that haue trauelled and Navigated those quarters, and also affirmed by a letter sent from Captaine *Artred* written to the King of *Spaine*: wherein recounting very diligently all the particulars of *Chyna*, sayd, that they long since vsed there both Ordnance and Powder: and affirming further,



that there hee found ancient ill-shapen Peeeces, and that those of later Foundings are of farre better fashion and mettall then their ancient were. Some also imagine that Powder and Ordnance were inuented by the famous Mathematician *Archimedes*, who made vse of them at the siege of *Syracusa* in *Cicillia*, and they ground that supposition vpon *Vitruuius*, who reporteth that one of his engins with a terrible noyse did shoote forth great Bullets of stone: which by reason of that report could neither bee supposed the *Catapulta*, *Balista*, *Scorpion*, nor any other of his knowne engins. Others say that Ordnance and Powder were vsed in the time of *Alexander* the Great, who hauing a purpose to besiege a City neere the river *Ganges*, was diswaded from it by some of his good friends that told him, the Citizens thereof were so much fauoured of *Iupiter*, that he vsually sent *Lightning* and *Thunder* from their walles, that destroyed whosoeuer offered to assault that City. And indeede if we shall well consider the nature and effect of Powder and Ordnance, we shall finde them to come so neere vnto naturall thunder and lightning, that I thinke we may well say, that as Nature hath long time had her Thunder and Lightning, so Art hath now hers. *Dionisius Halic* in his first booke of Antiquities reporteth, that *Alladius* the 12. King of the *Latins* after *Aeneas*, had inuented a meanes by art to counterfeite Thunder and Lightning, of purpose to make his Subiects beleue him to be a God, yet in the practising thereof he burned his house and himselfe together, each of which may be probably coniectured to be done with the materialls of Powder and Ordnance. Others affirme that a Monke of *Germany*, named *Barthold Shennart*, otherwise called the Blacke. Vpon a cettaine time (not thinking vpon Powder or Ordnance) in the yeere of our Lord 1300, hauing in his Morter a mixture of Sulpher and Niter for another vse; by chance a cole of fire falling into the same, caused it so to rarifie and blow it selfe away: that hee beeing therewith astonished, searched into the cause thereof, & vpon further tryalls, he found that the hot and dry qualities of the Sulpher being with coale and moysture combined and wrought together, with the cold and moyst qualities of the Niter, was apt by force to be suddenly vnloosed with great rarefaction, wherby by little and little he brought that vnhappy inuention of Gun-powder and Gunnes to perfection, to make vse thereof in Warres: which he revealing in short space made it common. *Beraldus* saith, that at the first inuention of Ordnance they were all called by the name of *Bombards* (a word compounded of the verbes *Bombo*, which signifieth to Sound, and of *Ardeo* to burne) and they that vsed them, they called *Bombardiers*, which name is yet partly retained. After which, as *Beriboldus* saith, they were called *Turacio* and *Turrafragi* of the breaking downe of Towers and Wals: and by *Iohn de monte Regio*, they were called *Tormentis*: their Shot *Sphera tormentaria*, and the Gunners *Magistri tormentorum*, But now Ordnance are eyther named at the will of the inuentors, either according to his own name (as the Canon was) or by the names of birds and beasts of prey, for their swiftnes, or their cruelty: as the Faulconet Faulcon, Saker and Culuering, &c. for swiftnesse of flying, as the Basiliske, Serpentine, Aspik Dragon, Syrene, &c. for cruelty, whose swiftnes, report, and terriblenes is properly and wittily expressed by the Latin Poet *Forcastorius*, as followeth.



*Continuo cana terrificis borentia bombis  
Aera & flamifferum, tormenta imitantia fulmen,  
Corripunt, Vulcanum dum Theutonas armas  
Inuentum: dum tela Iouis mortalibus afers  
Nec Mora, Signantes certam sibi quisque volucrum  
Inclusum salucrum cineres, sulphurq; nitrumq;  
Materiam accendunt, Seruata in veste fanilla  
Fomite correpta diffusa repente furis vis  
Ignea circumsepta: Simulq; cita obice rupto  
Intrusam impellis glander volas illa per auras  
Stridula et exanimis passim per Prata iacebunt  
Deiecta volucres, magno micat ignibus Aer  
Cum Tonitru: quo Silua omnes Ripaq; recurua  
Et percussa imo sonuerunt aquora fundo.*

Imitated by the Author, in English thus:

What Horrid roares proceed from Bombards soules  
By ayre made fire, Torments of lightning flashes  
From earth exhald, with vapours: Vulcan howles  
For that now on earth men can make thunder dashes;  
Ingenious Art now Aping Natures worke,  
Giues also name of birds and beasts of pray  
To Gunnes, wherein maine cruelty doth lurke,  
When powdred Peter, Coles and Napths assay  
To force the Sphæricke shot t'outflye Report,  
And by Report to make the Welkin roare,  
And Siluan cauernes, Echoes lowd retort,  
Batter, Sinke, Kill, yet ayming mischiefes more:  
For mercilesse they'l spare nor high nor low,  
Poore, fatherlesse, nor widdowes will they know.  
The deuills birds I thinke were fitter names  
To call them by, that spit such cruell flames.

R. N.

## CHAP. III.

Where Ordnance were first vsed in these parts.

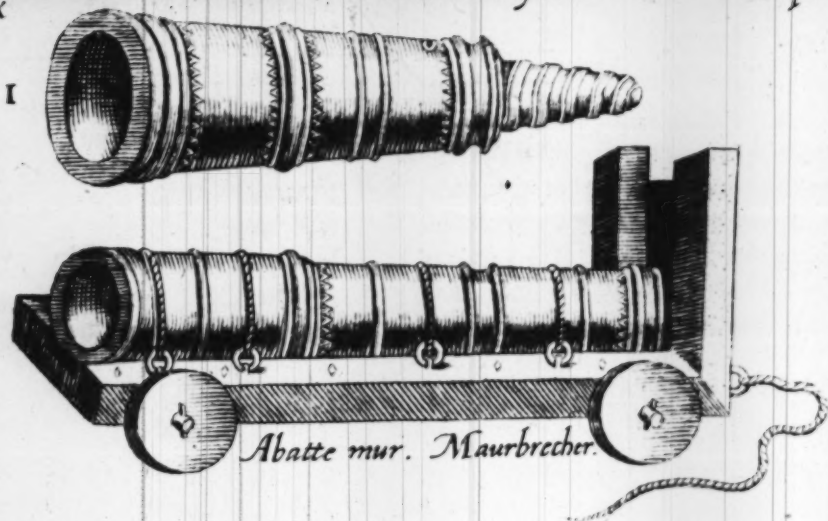


*Aulus Iulianus* the *Ligurian* Historiographer, a graue and authentick Author writeth, that in the yeare of our Lord 1366. when the Warres were hot betwene the *Venetians* and the *Genoweses*, certaine *Germanes* presented two Peeces of Iron Ordnance (wrought by hand) vnto the *Seignory of Venice*, with some prouision of *Powder* and *Laden Shot*; who receiued them very thankfully; especially seeing how that diabollicall vnknowne furie had not onely exceedingly feared, but also slaine so many of their Enemies, that thereby they preuailed and obtained a wished victory against their aduersaries, and accordingly got their owne descignes. And *Paulus Iouius* in his third booke reporteth, that the first Field Ordnance that were vsed in *Italy*, were in the Warres betwene the *Bannitoes of Florence*, and the house of *Mediges* brought by *Bartholmeo Coglioni*, and that the Prince of *Ferrara* hauing receiued a hurt in his foote by a Shot, from one of those small Peeces (mounted vpon wheelles as hee noteth.) The Prince earnestly complained, that *Coglioni* had behaued himselfe that day very maliciously against him, by vsing supernaturall Barbarisme, in making such horrible and vnaccustomed Tempests, to beat and spoyle his Men with, who had none other Weapons to defend themselues, but onely Swords and Speares. *Laonicus Chalon* in his fifth booke, reporteth that *Mahomet* the great Turke at the Siege of *Constantinople*, in the yeare of our Lord 1419, planted against it one peece of Ordnance, that he discharged seuen times in one day, which conveyed a bullet of 300 pound waight, and made the ground tremble a furlong round about it (at the discharge) with the report thereof. And he further affirmeth that the *Grecians* answered him againe with Peeces that shot bullets of 150 pound waight. *Pollidor Virgill* in his fifth booke of the English History writeth, that in the yeere of our Lord 1425, in the beginning of the reigne of the French King, *Charles* the seauenth, the English hauing besiedged the Towne of *Mantz* so battered the walle thereof, that they soone fell to the ground. And *Munster* in his second Volume writeth, that the Duke de *Barre* 1431, was defeated by the Count de *Vadement*, by meanes of the Ordnance that he vsed (both Canon and Culuering) which was a matter then so new and rare, that the Count himselfe at the shooting them off, fell alwayes on his face to the ground for feare. Ordnance were also vsed by the *Almaines* about the Coast of *Denmarke* in the yeare 1434. *Paulus Iouius* and *Guichardine* relate that *Charles* the eighth of France hauing vndertaken the Conquest of *Naples*, vsed Ordnance both in the Planes, and vpon the tops of high mountaines. And the *Italians* that deserbed his returne, said, that with his souldiers, he drew them vp ouer the tops of the *Appenyne* Mountaines, and so from place to place with admirable courage, where by reason of the steepnesse and roughnesse of the place, horses and cattell could not bee employed to draw them, but his horsemen did then carry the Shot & other Munitions to them belonging

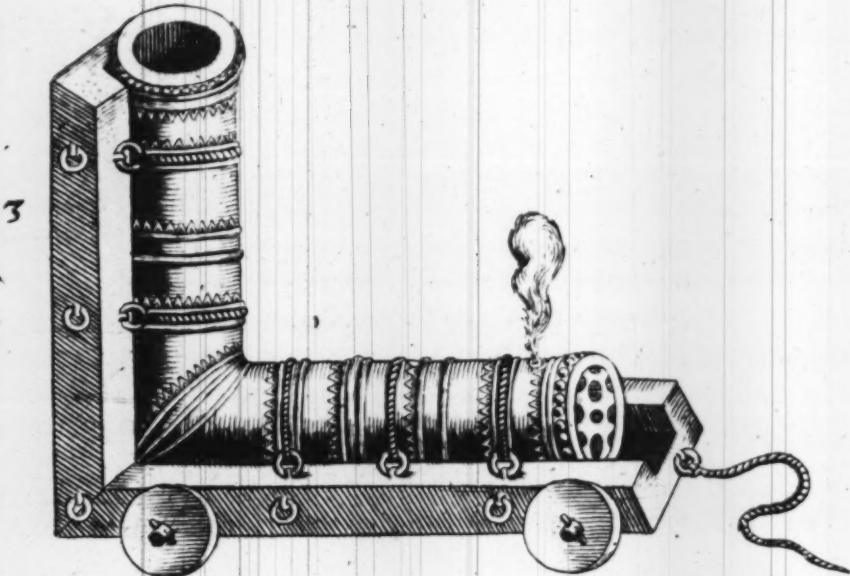




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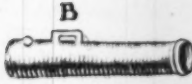
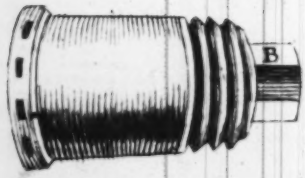
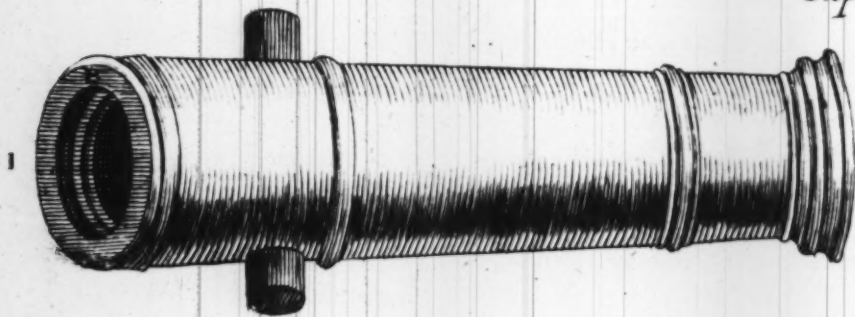


Abatte mur. Maurbrecher.



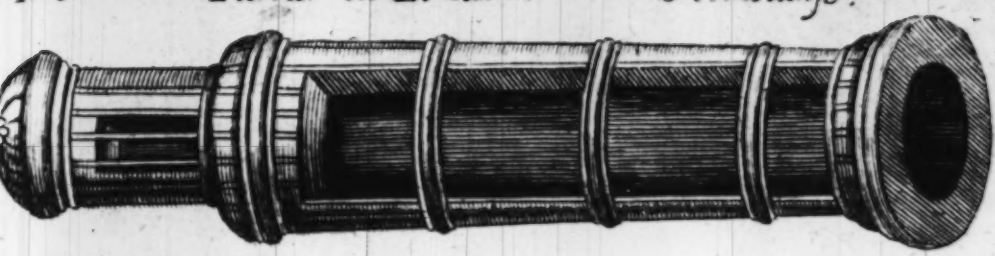
Eschelle a  
Ziel. le

v



Tract. de l'esp  
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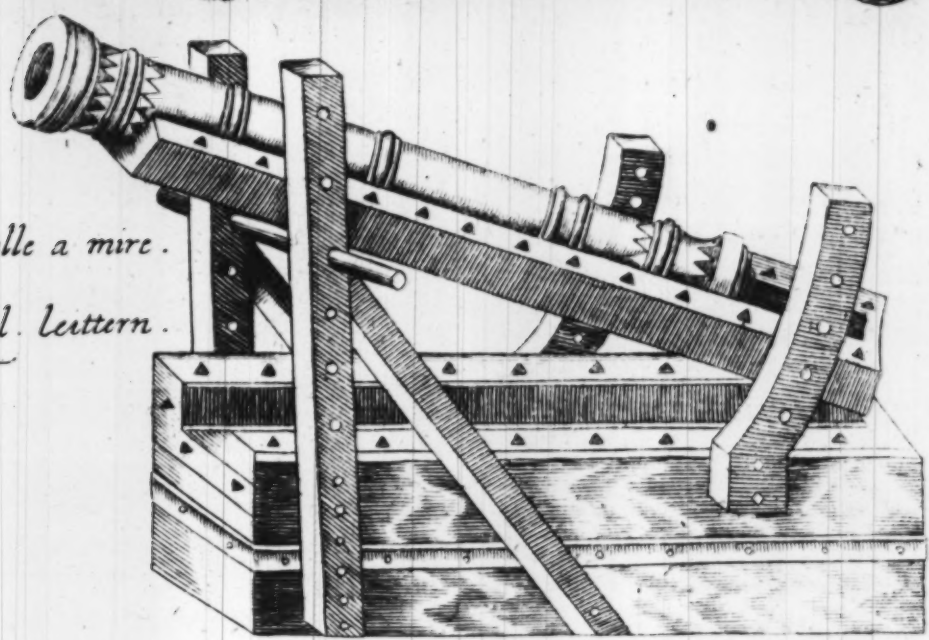


B

I

Echelle a mire.

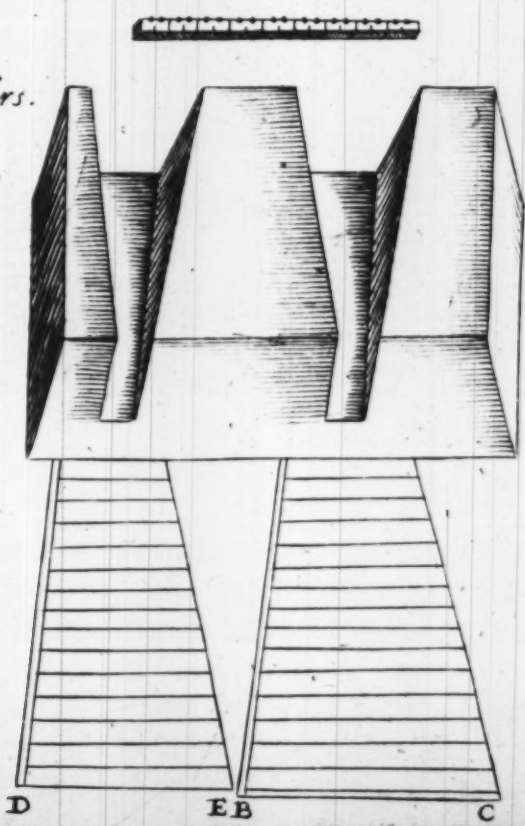
Riel. Leitern.



2

de l'espaule avec ses troniers.  
xplanades.

der Schutren mitt ihren  
gen und brüschern.



D

EB

C





belonging, each of them a little. *Camello Vitelli* is said to have inuented the Pistols and small Hand-gunues for horsemen, whereby *Ferdinand* of *Aragon* discomfited the *French* and *Almaines*. Muskets were inuented for foote-men, and first vsed at the Siege of *Rhege* in 1521: since which time their inuentions haue been so infinitely varied as no man can fully expresse: which now shall suffice me, and I hope will giue satisfaction to other men also.

CHAP. IIII.

Of what formes and fashions Ordnance were first made.



*C*aptaine *Vffano* saith, that at the first inuention of Ordnance they made them of yron bars by hand, with yron hoopes, and of seuerall fashions, as may appeare in the precedent figure at a and b.

The first was like to the common drinking Cannes (vsed in *England*) tapering lesse & lesse towards one end. hauing also a tapering skrew at the breech to fasten it into a peece of timber: but the same growing wider and wider from the breech to the mouth-wards, made the Shot thereof to scatter and to be of little force and of lesse (and most vncertaine) direction: these long since are quite out of vse, and for their fashions they were called *Screwed Tapers*.

The second sort were called *A bastemurs*, or *Beate walles*, and is represented therein at 2, they were not much vnlike *Bombards*, but were laide in Troughes or Trunke carriages with 4 truckes and two tymbers that rise vp at the breech to stay it in the carriage, and to performe the office of the Trunnions therein.

The third was called an *Elbow peece*, and is represented at 3 like a mans arme bended at the *Elbow* orthegonally, or at right Angles, whereupon it tooke that name, but it being also of little force, is likewise left and of no vse.

The fourth was a *Bombard* chambred which shot round stone shot, and is seldome (without alteration) vsed.

The fifth was called *Scala mur*, or the Scale wall, not much vnlike our Stocke fowlers, these two last are represented at 2 in the saide first figure b, differing onely in that our carriages which are made to mount, and imbase them by a sliding Standerd with holes and a trucke at the foot thereof.

And the sixt is like a Chambred Canon Perior, but that the Chamber is made of a Peece by it selfe skrewed into the Chafe, and hath Trunnions as is represented at VI in the first figure, but by reason of the great trouble to skrew it, the same is also out of common vse.

The seuenth Peece is nothing vnlike our Portingale-base, which with her Chamber, Tayle, and Hand stearne, to guide and direct it vnto the assigned marke, as is in the same figure represented at 2, being yet with vs of vse, especially in small vessells at Sea.

The three last they sometime did worke by Forge and Anuill, yet sometime they did cast the two first of these 3 both of Iron and brasse.

And thus much may serue to haue spoken of the Ordnance first formed of Antiquity.

# CHAP. V.

## *Of former forreigne Foundings of Ordnance.*



Vnne-Founders about a hundred, ora hundred and fifty yeares past did vse to cast Ordnance more poore, weake, and much slenderer fortified then now, both here and inforreigne parts: also the rather because Saltpeter cyther being ill or not refyned, their sulphur vnclarified, their coales not of good wood, or else ill burnt, making therewith also their powder cuilly receipted, slenderly wrought, and altogether vncorned, made it prooue to be but weake (in respect of the corned powder made now a dayes) wherefore they also made their Ordnance then accordingly, (that is much weaker then now:) for the powder now being double or treble more then it was in force of rarifaction and quicknes; requireth likewise to encrease the Mettall twice or thrice more then before for each Peece. For whereas then they allowed for the *Canon* 80 pound of Mettall for each pound that the Shot wayed, now they allow 200 pound & more for each pound of the Shot: and for Culuerings then they allowed but 100, and for Saker, Falcon, and lesser Peeces they were wont onely to allow 150 for one. But now for the Culuerings they allow 300, and for the small Ordnance 400 pounds, for each pound their seuerall shots of cast yron is to weigh. And as for forreigne Foundings that it may appeare how they differ from our English Ordnance, For I say that in *Spaine*, in *Germany*, and in *Italy*, they reckoning their *Canons* and *Culuerings* by the weight of their yron cast shot, they make at the least tenne sorts of cyther. For they haue *Canons* of 16, 20, 30, 40, 50, 60, 70, 80, 100, and 120, and *Culuerings* of 14, 20, 30, 40, 50, 60, 70, 80, 100, and 120, calling them *Canons* or *Culuerings* of so much as their Shot weigheth, hauing seuerall heights of their Diametres, wherein although the Canon of 20 or of 30, &c. shoote yron shots of equall weight, with the Culuering of 20 or of 30 being of like numeration, and also of like height of Bore, for the *Canon* of 30, shooteth a Shot of 30 pound waight, and so likewise doth the Culuering of 30, & the like is to be vnderstood of the Canon and Culuering of 50, 60, 80, or of 100 pounds, and so of the rest: yet doe they differ in the length of their Chases and fortification of their Mettalls, for the *Canons* are but about 18 Dyametres of their Bores in length, whereas their *Culuerings* are about 32 Dyametres of their Bore long. And besides they likewise differ in fortification of Mettall, the ordinary Canon being in her Chamber but  $\frac{2}{3}$  of her bore; and at her Trunnion but  $\frac{1}{2}$ , and at her Mouth but  $\frac{1}{3}$  of her bore in thicknesse of Mettall, whereas their ordinary *Culuerings* are fortified with the whole height of their Bores in their Chamber and with  $\frac{1}{2}$  at the Trunnions, and with  $\frac{2}{3}$  of the height of their bores, at their Mouthes in thicknes

thicknesse of mettall. Now because the Measures and Weights in those a-forenamed Dominions doe not agree at all with ours, their pound Troy being about one ounce and a halfe lighter then our pound Haberdepoyz, and their feete and inches *Brases*, and *Palmes* likewise differing among themselves, and much more from our measure of foote and inch of Alsise in *England*, as may appeare by the Scale here annexed, with the severall Tables; both theirs and our Ordnance are better to be distinguished & vnder-

$\frac{1}{4}$  Of a  
foote in

|                 |                |
|-----------------|----------------|
| Viena           | 6 a Pace       |
| Venice & Verona | 8 a Pace       |
| Grecia          | 10 a Pace      |
| Bauaria         | 6 a Pace       |
| Antwerp         | 10 a Pace      |
| Ferrara         | 8 a Pace       |
| Lorraine        | 10 a Pace      |
| Fraunce du Roy  | 8 a Pace       |
| England         | 20 a Geo: Pace |

A Table of  
Heights.

| lb. | inch.           |
|-----|-----------------|
| 14  | 4 $\frac{1}{2}$ |
| 16  | 4 $\frac{2}{3}$ |
| 20  | 5 $\frac{1}{2}$ |
| 30  | 6               |
| 40  | 6 $\frac{2}{3}$ |
| 50  | 7 $\frac{1}{3}$ |
| 60  | 7 $\frac{2}{3}$ |
| 70  | 8               |
| 80  | 8               |
| 190 | 9               |
| 120 | 9 $\frac{1}{2}$ |

stood in their Weights, Bores, and Measures, then many words can explaine, I haue first therefore wished, that my Brethren and louing countrimen (English Canoniers) should be also acquainted with those forreigne Ordnance; lest perchance being commanded to serue with some of them, they vnhappily should at first be dangerously mistaken therein: wherefore I haue likewise here annexed a Table, which will neerely reduce the Spanish heights vnto our measures of inches, and for the rest in regard their weights are so nigh one & the same among themselves in the pounds, & differing from our pounds Haberdepoyze, &c. it may also tolerably serue for them all in like sort, as the two examples following will I hope satisfie.

Example 1.

Admit there be a forreigne Canon or Culuering of 40, and the height of the Bore thereof be required.

Looke in this Table against 40, where you shall finde 6 $\frac{2}{3}$ , so you may conclude that the Bore thereof is to bee 6 inches  $\frac{2}{3}$  of our English Measures.

Example.



## Example 2.

And in like manner for a Canon or Culvering of 60, you may finde seven inches and  $\frac{1}{2}$ . But you must remember to allow  $\frac{1}{4}$  part of that height lesse, for the height of each shot, for the due vent thereof, as shall hereafter bee further shewed.

Wherby you may also perceine that the wonted allowance of  $\frac{1}{4}$  of an inch for the shot lower then the Bore of the Peece: for all Peeces Great and Small is no good proportion for allowing the vent generally, being but a generall *English* error, and reiected by vnderstanding Gunners, as hereafter when we shew how to finde the due vent for euery Peece shall more at large appeare.

In France they haue vsually these 6 Peeces. *vi*z.

|          | Bore.           | Leng. | Shot.           |
|----------|-----------------|-------|-----------------|
|          | deg.            | d. y  | lb.             |
| Canon    | 6               | 19    | 33              |
| Culu.    | 5               | 27    | 16              |
| Bast.    | 4               | 28    | 7 $\frac{1}{2}$ |
| Mini.    | 2 $\frac{1}{2}$ | 36    | 3 $\frac{1}{2}$ |
| Falc.    | 2 $\frac{1}{2}$ | 36    | 1 $\frac{1}{2}$ |
| Falconet | 2               | 37    | $\frac{1}{2}$   |

And 3 sorts of Shot, Stone, Iron and Lead, whereof the first is to the second subtriple, and the second to the third *Subsesquiteres* in waight.

## CHAP. VI.

Of later Founding for legitimate Ordnance.



He Emperour Charles the fifth, finding the great inconvenience in those confused varieties, consulted thereof with his Councell of Warre, and thereupon commanded, That all his Gunne-founders should thenceforth cast all Cannons of 13 Dyameters of their Bores in length, and to carry an iron Caste shot of 45 pound and allowed about 7000 waight of Metall for euery of those common Cannons for Battery: but for re-inforced Cannons (that is as we rearme them double fortified Cannons) to giue them one height of their Bore in thicknes of Metall at the Touch-hole, and  $\frac{1}{2}$  at the Trunnions, and  $\frac{1}{4}$  at the Mouth. and to be also in length 13 Dyameters of their Bore, wa ying in Metall about 8000 pound. But for lesse- ned Cannons being of like length he allowed but 6000 pound of Metall, being  $\frac{1}{2}$  thicke at the Touch-hole,  $\frac{1}{4}$  at the Trunnions, and  $\frac{1}{8}$  at the Mouth.

Whereupon these obseruations may well arise, That each sort of Ordnance

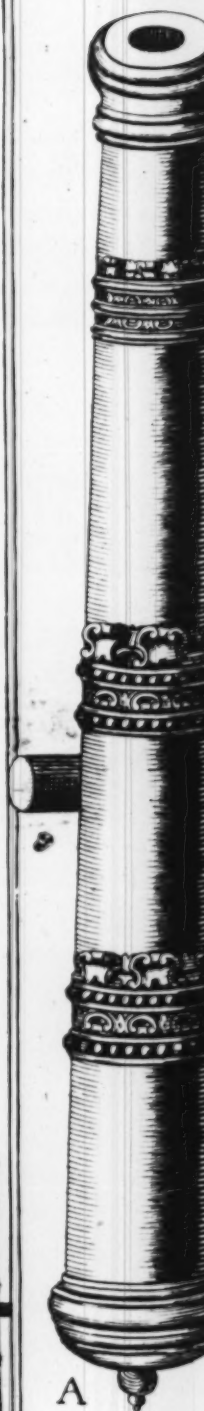
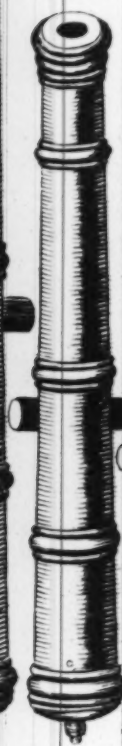
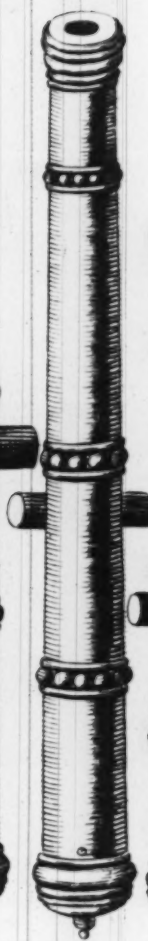
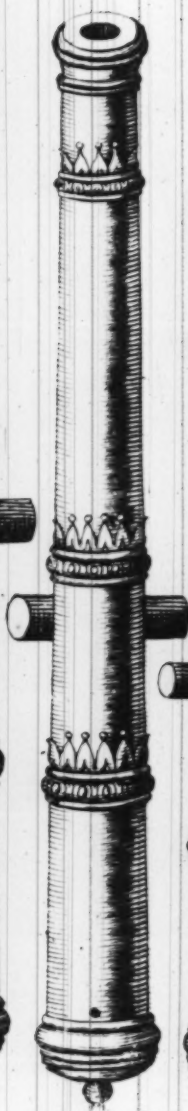
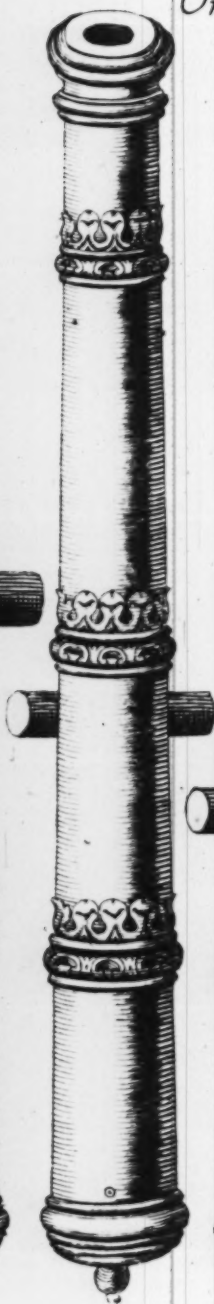


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Cap. 6. i.

Colubrines Legitimes.

Ordentliche Vndt rechte Veldtschlangen.



A

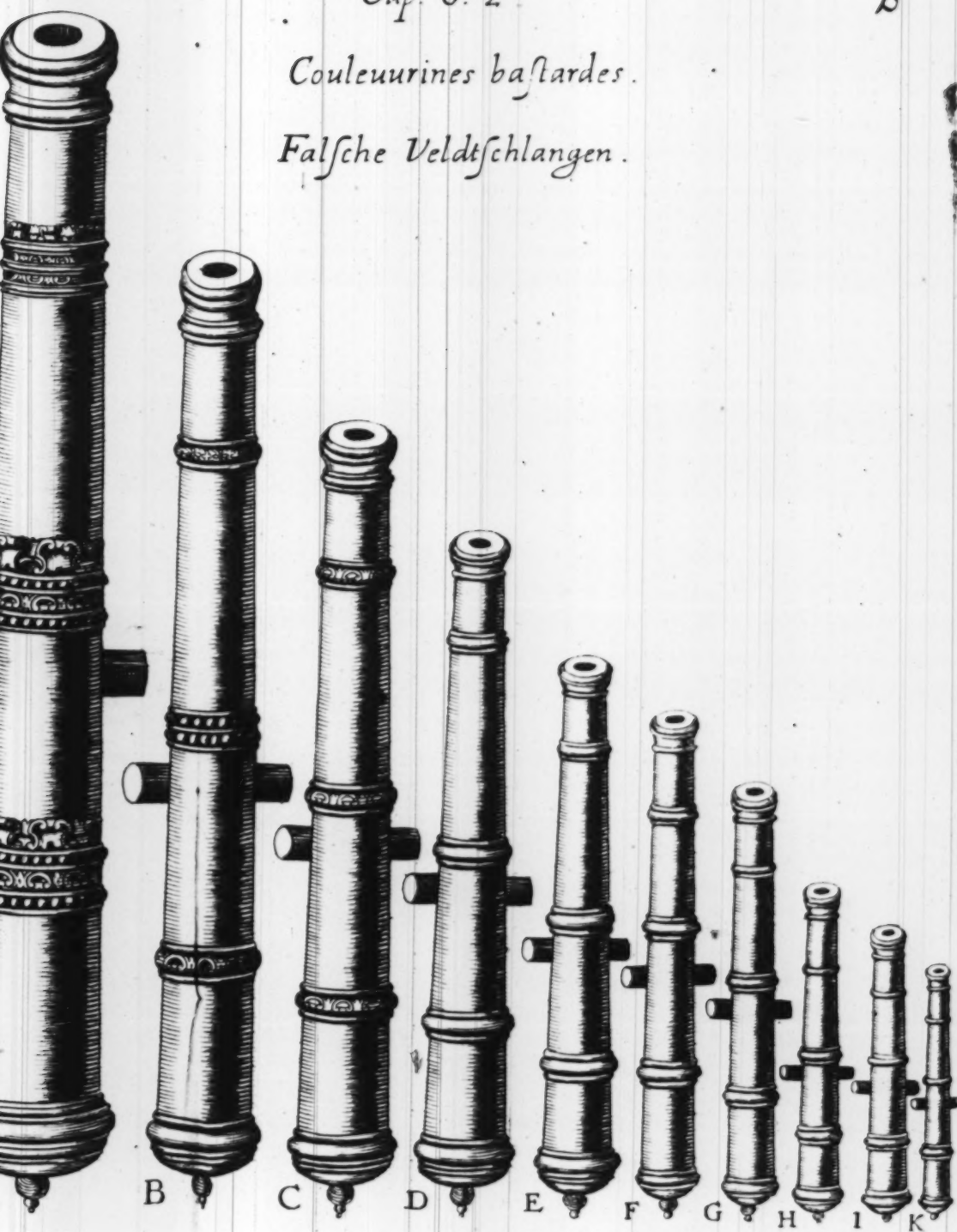


Cap. 6. 2.

<sup>e</sup>  
B

*Couleuvres bastardes.*

*Falsche Veldtschlangen.*





nance that are re-inforced or double fortified, being thicker or richer in Mettall both in their Chambers and Chases then the ordinary or lessened are, therefore able to beare and resist the force of more Powder to be fired in them then the others can, without danger, and so consequently doe greater execution against any strong resisting Obiect. And likewise wee may conceiue that the ordinary fortified Pieces may endure more, and doe more seruice then the Lessened can doe.

*Monsieur de Alot, Don Louis de Valasco, and Cond de Bucquoy*, late Generalls, or Masters of the Ordnance to the King of Spayne, considering the vtility and benefit of these Imperiall Orders, euery of them in their severall times gaue command to the Founders, that they should thenceforth cast all their Ordnance according to the proportions and Rules following.

Namely, that euery Ordinary *Canon* of battery should be made to shoote an yron round cast shot of 48 pound waight, with 24 pound of fine powder, or 27 of common powder, and to be in length 18 Dyametres of her bore, and fortified in thicknes of Mettall with  $\frac{1}{2}$  in her Chamber, and with  $\frac{1}{2}$  at the Trunnions, and with  $\frac{1}{2}$  at the Mouth, waighing about 6500 pound.

The re-inforced or double fortified Cannons to be fortified the thicknes of one Dyametre in Mettall at the Chamber or Piller of fire, at the Trunnions with  $\frac{1}{2}$  of a Dyametre, and at the Mouth with  $\frac{1}{2}$  of her bore, which were to bee charged with 48 pound shot, and 28 pound of fine powder, or 32 pound of common powder, and waighing about 7000 pound, being 18 Dyametres in length.

The Lessened *Canon* to bee  $\frac{1}{2}$  of a Dyametre of her bore in thicknesse of Mettall at the Chamber, and  $\frac{1}{2}$  at the Trunnions, and  $\frac{1}{2}$  at the Mouth, shoorting 48 pound shot with 20 pound of fine powder, the Chase being also 18 Dyametres of her bore in length, and to waigh about 5700 pound.

And to make their *Demy-cannons* as the re-inforced to carry yron shot of 24 pound waight, to be 20 Dyametres of the bore in length of their Chases, and weighing about 4500 pound.

The Quarter Canons (re-inforced also) 25 times the Dyametre of their Bores in length, and the shot of 12 pound, and the peece to waigh 2700 pounds.

Likewise they gaue Order to cast their ordinary *Culuerings* 28 Dyametres of their Bores in length to shoote a shot of 16 pound, with 16 pound of ordinary powder, or 12 pound of fine powder: but for the Lessened with 14 pound of common, or 10 pound  $\frac{1}{2}$  of fine powder, and the double fortified or re-inforced, with 18 pound of common, or 13 pound of fine powder. And their common *demy Culuerings* to be 30 Dyametres of their Bores in length, and more rich in mettall then the whole *Culuerings*, and their shot to weigh 10 pound, with 10 lb. of common powder, or  $\frac{1}{2}$  of fine powder namely: 8 pound. And for the Lessened 9 pound of common, or 7 pound  $\frac{1}{2}$  of fine powder: But for the re-inforced, 11 pound of common, or 8 pound  $\frac{1}{2}$  of fine powder.

And their *Sakers* or quarter *Culuerings* to bee 32 Dyametres of their Bore for length of their Chases, and to shoote 6 pound of iron shot with as much fine powder as the shot waigheth: and the like for the *Faulcons*, *Faulconets*, *Rabinets* and *Bases* which may be from 36 to 50 Dyametres of their Bores in length,



length, and the more fortified. And thus much for Moderne Legitimate Ordnance: as for Bastard Canons, Bastard Culverings, &c. they shoote higher shot, but are in Chafe fewer of their proper Dyameters in length. And for extraordinary Peecesthey are of lower height in their Bores, and in Chafe more their proper Dyameters in length, then the Legitimate are. And of both the Bastard Peecest, and of the extraordinary Peecest there are Common fortified, re-inforced or double fortified, or lesse, or lessened fortified Peecest, as well as of the Legitimate: each of such thicknes of metall in every member in proportion being compared with their proper Dyameters, as the ordinary, re-inforced, or Lessened legitimate Peecest are of, as the particulars with their names, waights, and proportions here vnder mentioned, with the Tables following will make manifest.

*Ordinary observations in Venice.*

A Peece being of 2 inches in height the shot waigheth 1 lb.

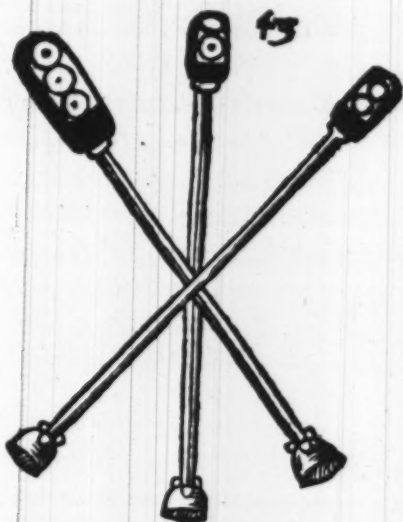
At 2 inches and  $\frac{1}{2}$ , 3 lb.  $\frac{1}{2}$ . At 3 inches 4 lb. At 3 inches one quarter 5 lb. At 3 inches and  $\frac{1}{2}$ , 6 lb. At 4 inches, 9 lb. At 4 inches and a halfe 11 lb. At 5 inches 16 lb. At 5 inches and a halfe 23 lb.

And note that all these shoote the full weight of their shot in powder. And also that their pound is but about 14 ounces Haberdapoy &c.

And their Observations for their greater Peecest appeareth by the Table and discourse following. *viz.*

|                     | Bore.<br>inch.   | Shot.<br>lb. | C Powd.<br>lb. |
|---------------------|------------------|--------------|----------------|
| Canons of 6 inches  | 5 $\frac{1}{2}$  | 26           | 18             |
| Canons of 7 inches  | 6 $\frac{1}{2}$  | 38           | 24             |
| Canons of 8 inches  | 7 $\frac{1}{2}$  | 64           | 42             |
| Canons of 9 inches  | 8 $\frac{1}{2}$  | 110          | 76             |
| Canons of 10 inches | 9 $\frac{1}{2}$  | 174          | 136            |
| Canons of 11 inches | 10 $\frac{1}{2}$ | 205          | 146            |
| Canons of 12 inches | 11 $\frac{1}{2}$ | 245          | 162            |
| Canons of 13 inches | 12 $\frac{1}{2}$ | 285          | 190            |
| Canons of 14 inches | 13 $\frac{1}{2}$ | 348          | 232            |

The Canons of 6, 7, 8, 9, and 10 inches they load with  $\frac{1}{2}$  of powder of their shots weight and load with 3 ladles full of powder for their charge, each ladle 3 bails long. But the Canons of 11, 12, 13, and 14 inches, they load with 4 ladles full of powder, each ladle being 1 Dyametre and a halfe of the shot in length. As the figure following describeth.



You may also further vnderstand, that for the 4 last mentioned *Canons*, the Ladle described in the midst of this figure serueth, being but one Dyametre and a halfe in length of the shots height : whereof 4 Ladlefulls maketh vp 6 Dyametres, which is  $\frac{1}{3}$  of nine which is alwayes accounted to containe waight for waight : namely, so much powder as will bee of equall waight with the iron cast shot, aswell for these as all other Peeces, which although it be not exactly so, yet may it serue for a generall estimate for a sodaine seruice to guesse a neere proportion.

### A Table of re-inforced Legitimate Ordnance.

|                                 | Weight, | Mir. | Co. | Leas | Best     |  |
|---------------------------------|---------|------|-----|------|----------|--|
| A The Dragon a Double Culuering | 14000   | 714  | 357 | 4252 | } paces. |  |
| B Whole Culuering               | 8500    | 630  | 315 | 3703 |          |  |
| C Demy Culuering                | 4600    | 470  | 235 | 2796 |          |  |
| D Saker or : Culuering          | 2650    | 366  | 183 | 2181 |          |  |
| E Faulcon                       | 1500    | 279  | 889 | 1659 |          |  |
| F Faulconet                     | 850     | 215  | 107 | 1280 |          |  |
| G Rabinet                       | 425     | 164  | 82  | 669  |          |  |
| H Base                          | 300     | 126  | 63  | 725  |          |  |

### A Table of Lessened Legitimate Ordnance.

|                                  |       |     |     |      |          |  |
|----------------------------------|-------|-----|-----|------|----------|--|
| A The Dragon or double Culuering | 11000 | 650 | 325 | 3164 | } paces. |  |
| B Whole Culuering                | 6300  | 570 | 285 | 3391 |          |  |
| C Demy Culuering                 | 3150  | 434 | 217 | 2558 |          |  |
| D Saker                          | 2000  | 334 | 167 | 1838 |          |  |
| E Faulcon                        | 1100  | 254 | 127 | 1514 |          |  |
| F Falconet                       | 600   | 196 | 98  | 1163 |          |  |
| G Rabinet                        | 350   | 150 | 75  | 895  |          |  |
| H Base                           | 300   | 180 | 40  | 842  |          |  |

## CHAP. VIII.

*Of Foundings of Bastard Peeces, with their Names, Waights, and Measures.*

Bastard Peeces are as I haue said, Ordinary, Re-informed and Lessened, namely the Ordinary of one Dyametre of her Bore in thicknes of Mettall at the *Touch-hole*, Re-inforced of more then one Dyametre, and the Lessened of lesse then one Dyametre thick there: each of which haue the name, the waight, proportion of powder, and of the shot allowed as followeth.

The ordinary *Basiliske* or *Bastard double Culuering* is about 26 Dyametres in length, and shooteth an iron cast shot of 48 pound, with 39 pound of Common, or 30 pound of fine powder, and weigheth 12200 pounds.

The *Serpentine* or *Bastard Culuering* is in length 27 Dyametres of her Bore, and shooteth 24 pound shot with as much common, or 19 pound of fine powder.

The *Spike* or *Bastard demy Culuering*, shooteth 12 pound shot, with 12 pound of fine powder, and is 28 Dyametres long, waighing 4050 pound.

The *Pellican* or *Bastard quarter Culuering* is 29 Dyametres of her Bore in length shooting fixe pound, with as much fine powder, weighing 2400 pound.

The *Bastard Faulcon* shooteth 3 pound shot, with 3 pound of fine powder, and is 30 Dyametres long, and waigheth 1350 pound.

The *Bastard Rabinet* shooteth an iron shot of 1 pound, with so much fine powder, and is 31 Dyametres of her Bore in length, weighing 750 pound. These afore said are Ordinary Bastard Peeces for the Reinforced and Lessened: the Table following will describe.

*A Table of Bastard Peeces reinforced by Mettall.*

|   |            | Waight | bymettle   | Leuell | Best        |
|---|------------|--------|------------|--------|-------------|
| A | Basiliske  | 14660  | 659 paces. | 329    | 3921 paces. |
| B | Serpentyne | 8100   | 590        | 295    | 3511        |
| C | Aspicke    | 7600   | 440        | 220    | 2618        |
| D | Pellican   | 2550   | 344        | 172    | 2044        |
| E | Faulcon    | 1500   | 261        | 132    | 1553        |
| F | Rabinet    | 800    | 202        | 101    | 1198        |
| G | Basc       | 450    | 120        | 72     | 916         |



A Table of Bastard Peeces Lessened.

|              | Waight | by mettle | Level | Best |
|--------------|--------|-----------|-------|------|
| A Basiliske  | 10500  | 595       | 298   | 3540 |
| B Serpentine | 6300   | 530       | 265   | 3153 |
| C Aspyke     | 3700   | 400       | 200   | 2028 |
| D Pellican   | 2100   | 310       | 155   | 1844 |
| E Faulcon    | 1200   | 212       | 118   | 1407 |
| F Rabinet    | 650    | 182       | 92    | 1086 |
| G Base       | 155    | 139       | 70    | 825  |

Thus much for the Common fortified Peeces, and these Tables for Lessened & re-inforced, as well for Bastard as for extraordinary Peeces which will further satisfie the Reader in particulars then many words : which because they are plaine enough, I think they shall need no further explanation.

CHAP. I X.

Of Foundings of Extraordinary Peeces with their Names, Waight and Measures.



Extraordinary Peeces hauing as I said, longer Chases, and lower heights of Bore then cyther the Legitimate or Bastard Peeces are neuertheless of 3 sorts also; as the Ordinary fortified with one Dyameter thicke of Metall at the Touch-hole, and the re-inforced with more then one Dyametre, and the Lessened with lesse then one Dyametre of their proper Bore in thicknes there at the Touch-hole, euen as we haue already said both of the Legitimate and Bastard Peeces also. And first the Ordinary haue the measures and weight following.

The Flying Dragons, ordinary or extraordinary Double Culuerings are of 29 Dyametres of their Bore in length of their Chases, and shoote 32 pound of iron cast shot, with 27 pound of Common, or 22 pound  $\frac{1}{2}$  of fine powder, and waigh about 12200 pound, shooting by mettle, or *Mira Com.* 638, leuell 319 paces, best 3790 paces.

The Syrene or extraordinary whole Culuerings are 40 times in length, the height of their Bores, weigh 6900 pound, and shoote 16 pound iron shot, with 16 pound of Common, or 12 pound  $\frac{1}{2}$  of fine powder, shooting by mettle 560 paces, leuell 250 paces, best 3332 paces.

The Flying Sparrowes, or extraordinary Demy Culuerings are in length 41 times the height of their Bores, shooting 8 pound iron shot, with 9 pound of Common powder, or 7 pound  $\frac{1}{2}$  of fine powder, and waigh 4100 pound, shooting by Metall 420 paces, leuell 220 paces, at the best Randon 2499 paces.

The extraordinary *Sakers*, or *Quarter Culuerings extraordinary*, are 42 times in length, the height of their Bores: and shoot, a shot of 4 pound of cast iron, with 6 pound of Common, or 4 pound  $\frac{1}{2}$  of fine powder, and weigh 2350 pound, shooting by Mettall 316 paces, leuell 158 paces, Best, 1941 paces.

The *Extraordinary Faulcons* haue 43 times the height of their Bores in length of their Chafes, shooting 2 pound of iron shot with 2 pound of fine powder, and weigh 1350 pound, shoot by mettall 249 paces, Leuell 124 pac. Best 1481 paces.

The extraordinary *Rabinets*, or *Passengers*, are 44 times their Bore in length, and weigh 775 pound, shooting 1 pound of iron shot, or 1 pound  $\frac{1}{2}$  lead, with 1 pound  $\frac{1}{2}$  of Common, or 1 pound  $\frac{1}{2}$  of fine powder, shooting by mettall 192 paces, Leuell 96 paces, Best 1142 paces.

The extraordinary *Bases* weigh 450 pound, and are 45 Dyametres, their shot are  $\frac{1}{2}$  pound of iron, or  $\frac{1}{2}$  of Lead, with as much fine powder, shooting by the Mettall 147 paces, Leuell 74 paces, and at their best Randon 876 paces.

The Re-inforced and Lessened extraordinary *Peeces* are made apparant by these Tables following.

*A Table of Re-inforced extraordinary Peeces.*

|   | <i>Flying</i> | <i>By Mettall</i> | <i>Leuell</i> | <i>Best</i> | <i>Waight</i> |
|---|---------------|-------------------|---------------|-------------|---------------|
| A | Dragon        | 658               | 329 paces.    | 3936 paces. | 14000 lb.     |
| B | Syrene        | 590               | 295           | 3511        | 81000         |
| C | Sparrow       | 440               | 220           | 2618        | 4600          |
| D | Saker         | 348               | 174           | 2044        | 2600          |
| E | Faulcon,      | 261               | 130           | 1553        | 1500          |
| F | Rabinet       | 202               | 101           | 1198        | 800           |
| G | Base          | 154               | 77            | 916         | 500           |

*A Table of Lessened extraordinary Peeces.*

|   | <i>Flying</i> | <i>By Mettall</i> | <i>Leuell</i> | <i>Best</i> | <i>Waight</i> |
|---|---------------|-------------------|---------------|-------------|---------------|
| A | Dragon        | 595 paces         | 297 paces.    | 3540        | 10500 lb.     |
| B | Syrene        | 530               | 265           | 3153        | 6300          |
| C | Sparrow       | 400               | 200           | 2018        | 3700          |
| D | Saker         | 310               | 155           | 1824        | 2100          |
| E | Faulcon       | 236               | 118           | 1407        | 1200          |
| F | Rabinet       | 183               | 92            | 1081        | 650           |
| G | Base          | 139               | 69            | 829         | 350           |

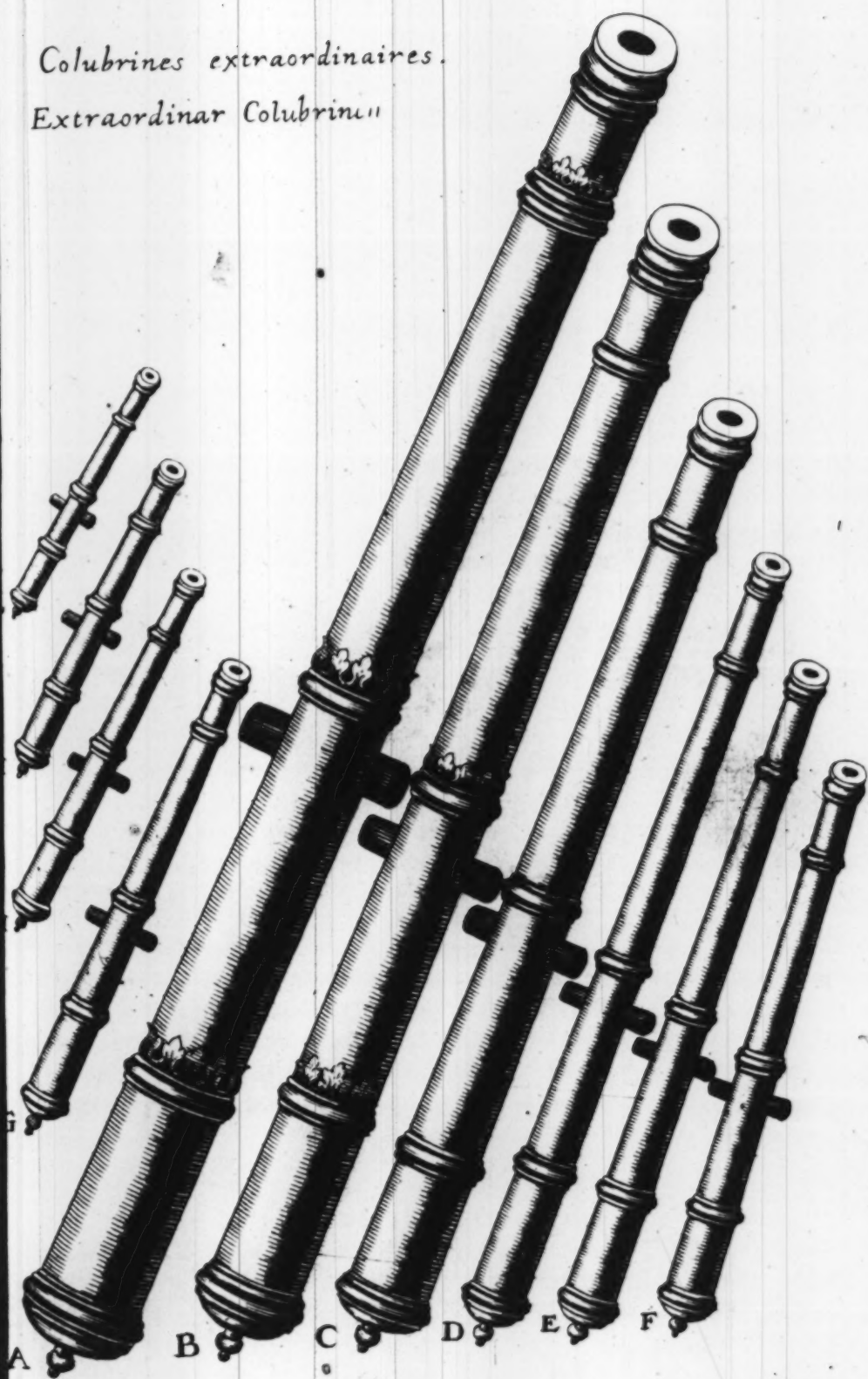
There rests yet another kind of moderne *Forreigne Peeces* inuented by *Inan Mauriga Lara* that shoote onely Stone or Murthering Shot, which are onely Taper bored in their Chambers, not much vnlike our Drakes, where-of there were 3 sorts.

The first of them were 15 times the Dyametre of their Bore in length, and called *Rebuffes*.

The

Colubrines extraordinaires.

Extraordinar Colubrinu







The second sort were 16 times their Bores in length called a *Cracker*. And the third were 17 Bores in length, and called *Ferrates*, all which are represented in the third figure at #.

These last mentioned (as also our *Drakes*) may eyther be reckoned among the sorts of Canon Periors, (being they are neerer the length of Dyameters) but shooting iron shot, are neerer vnto the sorts of Cannons of Battery: wherefore I conceiue they may properly bee estimated as Bastards to the one, or els as extraordinary to the other of these sorts, for the reasons before allcadged. And thus much may suffice to speake of Forreigne Pounding.

CHAP. X.

Of our English Ordnance distinguished into 4 kindes, and those generally diuided into seuerall sorts as followeth.



He Ordnance that are vsually founded in England, may very fitly be diuided into foure seuerall kindes in respect of the height of their Bores, length of their Chases, Fortification of their Metall, and the vses for which they are to serue, whose differences each from other I here intend to shew in generall, beginning with the Greatest; namely, the *Canons of Battery*, which we reckon to be the first kind, They differ very much from the other three kinds, as will appeare by comparing the height of their Bores, with the length of their Chases, The height of their Bores being all between 8 inches, and 6 inches Dyametre; and the length of their Chases being between 15 and 22 Dyameters of their proper Bores; in fortification of metall they differ also, for that they neuer exceede one Dyametre of their Bores in thickeesse of Metall at the Touch-hole. They differ in vses, as being onely vsed in Batteries, which the rest are not except the *Culuerings* (which are sometimes also vsed to pierce and cut out those ruines that the *Canons* haue loosened and shaken) Cannon shot being heauiest, because greatest, therefore onely and most fitly vsed to batter the *Enemies Walls*, Curtins, Bulwarks, and Defences: Of the *Canons of Battery* there are three sorts: Namely, the double Canon, or Canon Royal, or Canon of 8, whose Bore is 8 inches and vpwards, in the height of her Dyametre, and being 15 or 16 Dyameters long in her Chase, the second sort is called the *Whole Canon*, or Canon of seuen, being 7 inches in height, and about 18 Dyameters long. The third sort of this first kind are the *Demy Canons*, of about 6 inches in height of the shot, and 20 or 22 Dyameters in length, Of this kind may also the *Minions* and *Drakes* be reckoned. Of the second kind wee reckon the *Culuerings* and their Consorts which

which are in height of Bore between 5 inches and  $\frac{1}{2}$ , and 1 inch  $\frac{1}{2}$  Dyametre, and in length of their Chases they may be betweene 28 and 60 times the Dyametre of their owne Bores, and in fortification being neuer lesse then one whole Dyametre of Mettall in thicknes at their Châbers: Of this kind are many seuerall sorts; namely, all such lesser Ordnance as shoote iron shot, As the double Culuering, the whole Culuering, Demy Culuering, Saker, Faulcon, Faulconet, Rabinet, and Base, &c. whereof I shall hereafter speake more in particular. The smaller of this kind are of the more Dyametres of their Bores in length, and better fortified in thicknes of Mettall, each hauing also respect to their owne proper Bore. Of the third kinde are the *Periors*, or such Peeces as onely shoote Stone, or els Murthering Shot, both which, and Fireballs may be likewise shot out of any of the aforementioned Ordnance. And there are also seuerall sorts of Peeces of this third kind, all which are distinguished from the Ordnance of the fourth kinde, for diuers respects, especially for length, being 8 or more Dyametres of the Bore at the Mouth in length of their Chases. The sorts of this kind are the *Canon Perior*, the *Periera*, the *Port Peece*, the *Stocke Fowler*, the *Sling*, *Bombard*, &c. of each of which more shall be saide in their proper places hereafter. Of the fourth kind are all sort of Peeces that either shoote stone shot, Fireballes, Murthering shot, or els no shot at all. The sorts of this kind are the *Mortier Peeces*, *Murthersers*, *Pettards*, &c. being in length vnder 6 times the height of the Bore of their Mouthes, of each sort of this kind some are bigger, and some lesser according as the assigned seruice requireth.

*A Table out of Alexander Bianco, each pace two foote  
and a halfe for Randons of the 6 Poynts of  
the Gunners Quadrant.*

|                       | Poynt<br>Blanke. | 1    | 2    | 3    | 4    | 5    | 6    |
|-----------------------|------------------|------|------|------|------|------|------|
| <i>Faulconet</i>      | 180              | 750  | 1275 | 1590 | 1710 | 1785 | 1800 |
| <i>Faulcon</i>        | 260              | 1100 | 1870 | 2332 | 2508 | 2618 | 2640 |
| <i>Minion</i>         | 240              | 1000 | 1650 | 2046 | 2340 | 2412 | 2440 |
| <i>Saker</i>          | 300              | 1250 | 2125 | 2650 | 2850 | 2957 | 3000 |
| <i>Demy Culuering</i> | 348              | 1450 | 2465 | 3074 | 3306 | 3451 | 3480 |
| <i>Culuering</i>      | 360              | 1500 | 2550 | 3180 | 3420 | 3570 | 3600 |
| <i>Demy Cannon</i>    | 312              | 1300 | 2210 | 2756 | 2964 | 3094 | 3120 |
| <i>Canon of 7</i>     | 324              | 1350 | 2295 | 2865 | 2978 | 3113 | 3240 |
| <i>Canon of 8</i>     | 360              | 1500 | 2550 | 3180 | 3420 | 3570 | 3600 |

This Table seemeth to bee Calculated after the Comon Pace, which is but  $\frac{1}{2}$  if the Geometricall Pace, and must out of doubt be so vnderstood, as he himselfe in some part of his Booke acknowledgeth, which I thought fit to giue notice of to auoid misprissions, and for making the matter more plaine. Which the Reader may reduce by taking  $\frac{1}{2}$  of euery number.

I haue here also added another vsuall Table for English Ordnance, wherein



wherein I acknowledge some errors are, because exactnes in Tables of this Nature is not to be expected, by reason of the infinite diuersities of Materials and Accidents: But it may so become vsfull neuerthelesse, because it resonably pointeth at what should be in this matter expressed precisely, if it were possible, which the curteous Reader I hope will accept of vntill better come.

A Table of Ordinary proportions allowed for English Ordnance.

|                            | Bore.  | Height of the Shot. | Weight of the Shot. | Weight of Serpentine Powder. | Ladles length. | Ladles breadth. | Length of the Peece. | Weight of the Peece. | Weight of Corne powder. |
|----------------------------|--------|---------------------|---------------------|------------------------------|----------------|-----------------|----------------------|----------------------|-------------------------|
|                            | Inches | inch.               | lb.                 | lb.                          | inch.          | inch.           | foot.                | lb.                  | lb.                     |
| Canon Royall, or, Canon of | 8      | 7½                  | 63                  | 40                           | 24             | 14              | 12                   | 8000                 | 27                      |
| Canon of                   | 7      | 6½                  | 39                  | 25                           | 22             | 12½             | 11                   | 7000                 | 18                      |
| Demy Canon                 | 6½     | 6¼                  | 30                  | 20                           | 21             | 11½             | 10                   | 6000                 | 14                      |
| Whole Culue.               | 5      | 4½                  | 15                  | 14                           | 19             | 9               |                      | 4300                 | 10                      |
|                            | 5¼     | 5                   | 1½                  | 15                           | 20             | 10              | 12                   | 4400                 | 12                      |
|                            | 5½     | 5½                  | 20                  | 16                           | 21             | 11              |                      | 4600                 | 15                      |
| Demy Culue.                | 4½     | 4                   | 9                   | 8                            | 17             | 7               |                      | 2200                 | 6                       |
|                            | 4¼     | 4½                  | 10½                 | 9                            | 18             | 8               | 11                   | 2400                 | 7½                      |
|                            | 4¼     | 4½                  | 12½                 | 10                           | 19             | 9               |                      | 2500                 | 8                       |
| Saker                      | 3½     | 3¼                  | 5                   | 5                            | 30             | 9               |                      | 1400                 | 4                       |
|                            | 3½     | 3½                  | 5½                  | 5½                           | 31             | 9½              | 9                    | 1500                 | 4½                      |
|                            | 4      | 3½                  | 5½                  | 5½                           | 32             | 10              |                      | 1600                 | 5½                      |
| Minion                     | 3½     | 3                   | 3½                  | 3½                           | 25             | 5½              | 7½                   | 1200                 | 3                       |
| Falcon                     | 2½     | 2½                  | 2½                  | 2½                           | 22             | 5               | 7                    | 700                  | 2                       |
| Falconet                   | 2½     | 2                   | 1½                  | 1½                           | 18             | 3½              | 6                    | 500                  | 1                       |
| Rabinet                    | 1½     | 1½                  | ½                   | ½                            | 11½            | 2½              | 4                    | 300                  | ½                       |
| Bale                       | 1½     | 1                   | ½                   | ½                            | 9              | 2               | 3½                   | 200                  | ½                       |

For the *Culuerings* whole shot weigheth 18 pound, you must abate ½ which is 3 pound, for then the powder must weigh 15 pound.

For the *Canon* abate 1.

For a generall obseruation take that a Ladle 9 bails in length, and 2 bails in breadth, will very neere containe the iust waight in powder, that the iron cast shot for any Peece waigheth.

And also that the powder here mentioned is for Serpentine powder, which being now out of vse, the Corne powder being ½ stronger, therefore ¾ of these weights is to be abated, as in the last Columne appeareth.

## CHAP. XI.

Of the Canons of Batterie in particular, or of the first kinde,  
and their sorts.



It would be too tedious and long, yea and almost impossible to shew all the differences and inequalities in the Weights and Measures of severall Peeces of one same kind and sort of Ordnance that have been cast, or yet are at this time remaining in severall Fortresses of England and other countries, besides such as are here & there yet daily Founded or vually made either according to the Princes and the Officers of the Ordnance invention and wills, or some Founders opinions and selfe concepts. But forasmuch as it is a matter of greatest importance for every Gunner that taketh charge of Ordnance, to know perfectly of what kind and sort every Peece that is committed vnto him to manage and serue with, is; and whether they be sufficiently fortified or not, and to discern and examine whether any defect be amongst them, and so to be able thereby to iudge what powder each Peece in loading is able to endure, with safety to performe her vttermost seruices, considering then withall that Powder is now reduced into a greater perfection for force then formerly it was, wherefore former proportions are to be altered now: otherwise by ignorance or oversight they may more endamage their owne side then their Enemies. Some Peeces being but poorly fortified, are too long to beare a sufficient loading, others are too short to beare their full charge of powder requisite to carry their shot home to the assigned seruices; some are too light and, and some too heavy in their breeches, by misplacing their Trunnions in making the mold for their foundings, being too light they danger the vawmures, and by being too heavy in their Mettall towards their Breech, they become unwieldie and troublesome to Manage.

There are three sorts of Canons of Batterie, namely, the Canon Royall, or double Canon, they are vually 15 times in length, the Dyametre of their Bores, which is about 8 inches in height.

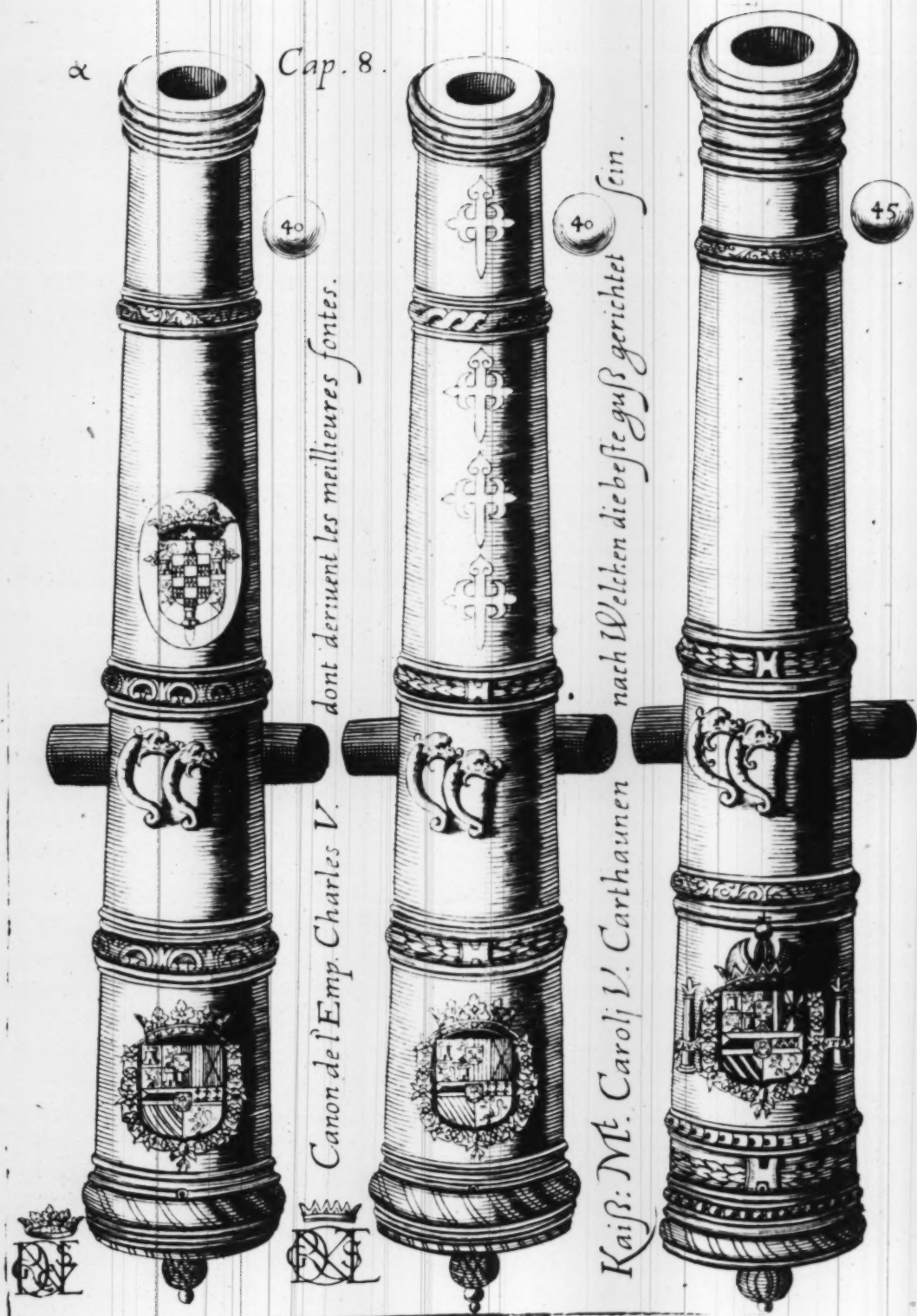
The next is the Whole Canon, or (as it is called) the Canon of 7, being about 7 inches in Dyametre of Bore, and in length of their Chases about 18 such Dyametres.

The third sort is the Demy Canon, which is about 6 inches, and  $\frac{1}{2}$  in Dyametre of Bore, and their ordinary fortifications for each of these are  $\frac{1}{2}$  of dyametre thicke in Mettall at the Chamber, and  $\frac{1}{4}$  at the Trunnions, and  $\frac{1}{8}$  at the Coronish, and  $\frac{1}{16}$  at the Mouth. But of late some Founders have given vnto the Demy Canons the full thicknes of one whole dyametre in Mettall at their Chambers; allowing for every one pound weight of their shot some 220 or 143 pound of Mettall (for the biggest of this kinde) and more, others in proportion for the least.

These







α

Cap. 8.

40

dont derivent les meilleures fontes.

Canon de l'Emp. Charles V.

40

nach Welcken die beste guß gerichtet sein.

Kaiß: Mt. Carolij V. Carthaunen

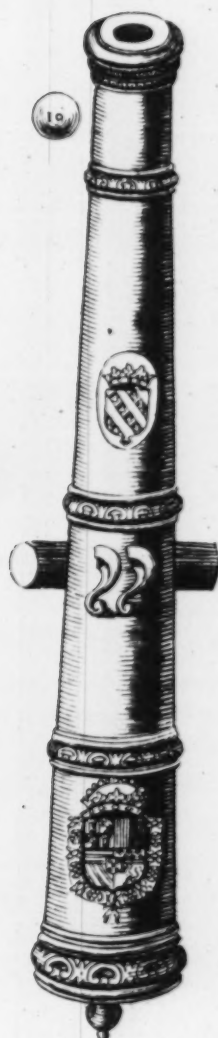
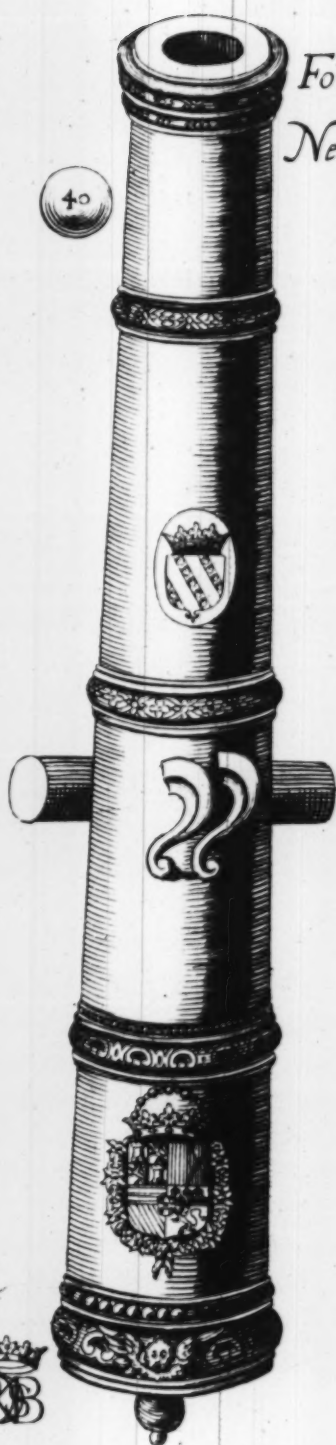
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Cap. 9.

4  
B

Fonte nouvelle de l'Archiducq Albert.

Neuw guß Ertzhertzen Albertj.







These three are onely vsed in Batteries against strong Walles and defences of the Enemies, because their greater weight of shot doth shake more the lighter can, namely more then the demy Culuering, (although the same shooteth and pierceth further) as by experience is daily scene. But forreigne Canons were formerly, and are in some places, as we haue already said, named according to the weight of their shot, being of 20, 30, 40, 50, 60, 70, 80, 90, 100 and 120 pound, and most of them 18 times the dyametre of their Bores in length of their Chases.

CHAP. XII.

Of Culuerings, or the second Kinde of Ordnance, with their seuerall sorts.



The second kind of Ordnance are the *Culuerings*, of which are five sorts, the *Saker*, *Faulcon*, *Falconet*, *Rabinet* and *Base*, wherein the Moderne founded *Culuerings*, *Sakers*, &c. doe much differ also from the Ancient, and our moderne English also from the former forreigne Ordnance, especially in Length, Bore, and Fortification, for that in former forreigne Foundings, they did as we said before cast the *Culuerings* to shoote

iron shot of 14, 20, 30, 40, 50, 60, 70, 80, 100, and 120 lb. waight, and called them *Culuerings* of so much as their iron shot was in waight, and they then allowed them not above 150 pound weight of *Mettall* for each pound weight of their shot, and allowed them also to be but between 24 & 32 dyametres of their shot in the length of their Chases, with one dyametre of thicknes of *Mettall* (at the most) in their Chambers or Columes of fire, each *Culuering* being now 30 or 32 dyametres of their Bore in the length of their Chases.

But of late (as I before said) they allow *Falcons* and *Falconets* to bee 36 or 40 dyametres of their bores in length, &  $1\frac{1}{2}$  or  $1\frac{1}{4}$  of mettall at their Chambers, with 250 pound, 300 pound, and sometimes more of mettall for each pound their proper shot doth weigh. The sorts of this kind by reason of their greater lengths of more dyametres shoot further & pierce deeper then those of the first kind, being loaded with as much powder as can be burnt in them whilst the shot remaineth within the Cillinder of the Peece, but being loaded with lesse, it abateth her vtmost execution, if with more it increaseth their danger of breaking the Peece, and some of the powder will goe then out vn-fired, or it being fired out of her Chases, &c. little or nothing doth further the course or way of the shot. Wherefore the proportionall length fitted to their calibres, and the conuenient charge of powder in respect thereof, and of the weight of the shot mentioned in the *Theoremes* of my first part of the *Art of Artillery* will most aduance the shot with all aduantage possible. And for their vses they differ much, notwithstanding that they be reckoned as of one same Kinde, for the Greater sorts: namely,

*Culuerings* and *Demy Culuerings* serue to pierce & cut out in batteries what the *Cannons* haue shaken and loosed: the *Sakers* and *Falcons* serue for *Flankers*, the other smaller sorts of this kind, for *Field Peece*s for the assaults, and to shoote at *Troopes* or *Companies* of men that are neere together. Al these shoote iron shot, but may shoote stone shot where the marks are but tender, and so they will saue much in *Amonition*, and yet performe as good seruice as with the iron shot they can doe.

*Alexander Bianco* in his Booke intituled *Corona e palma militare de Artiglieria* sayth, That their Founders in *Italy* as I conceiue, becaule their *Culuerings* shoote shot of equall dyametre with their greatest *Cannons*, & therefore would, if those great *Culuerings* were not vnweldie, shoote further, pierce deeper, and shake and vnloose more then their *Cannon*: for the reasons aforesaid they haue of late yeeres cast fewer *Canons* (and more *Culuerings*) then heretofore, commending their force and seruice farre beyond the *Canons*.

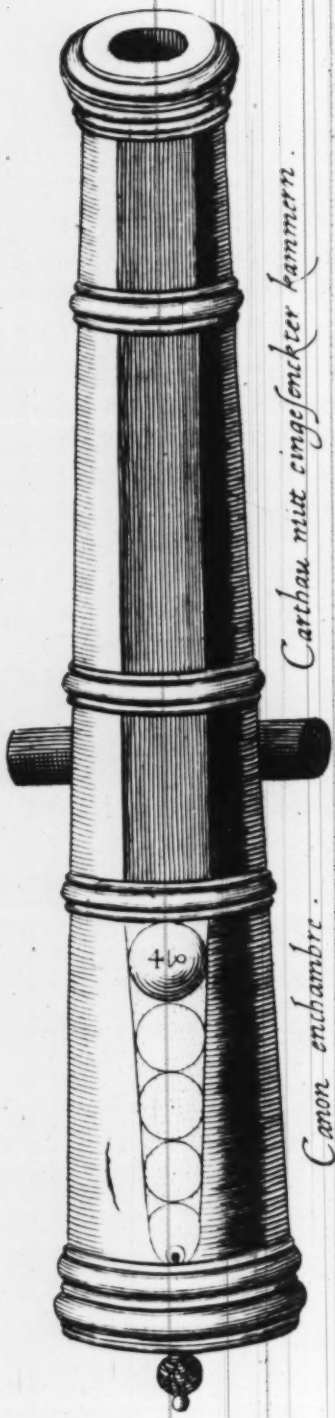
But *Diego Vffano* Captaine of the *Artillerie* in the Castle of *Antwerpe*, for reasons in his *Traicte de Artillerie* shewed, denyeth the *Culuerings* to be of equall worthinesse with the *Cannons*: which difference groweth by reason that now *Batteries* are made at shorter distances then heretofore: namely, within the *Canons* right Range, as at 80, 90, or 100 paces, so their opinions (both being iudicious Gunners) I conceiue to grow from the alterations also of Foundings, according to the Imperiall orders before mentioned, which in these parts of *Italy* were not knowne as it seemeth by *Bianco* Chiefe Gunner of *Cremes*, in the year 1603, nor altered from the aforesaid forreigne Foundings, whereby wee may conceiue that their seeming differences may be easily moderated by the iudicious Reader. Now for the *Harquebuse a Croke*, being in these dayes seldome vsed but at Sea, where especially, with an Arrow, it is a very galling and seruiceable *Peece*, and may safely bee discharged 300 times in one day, or 25 times in an houre: his leaden shot weigheth but three ounces, and it is charged with two ounces of Powder, and by reason of the length thereof, might be also accompted of this kind, but that it is a *Hand-gunne*, and so appertaineth not properly to this discourse.





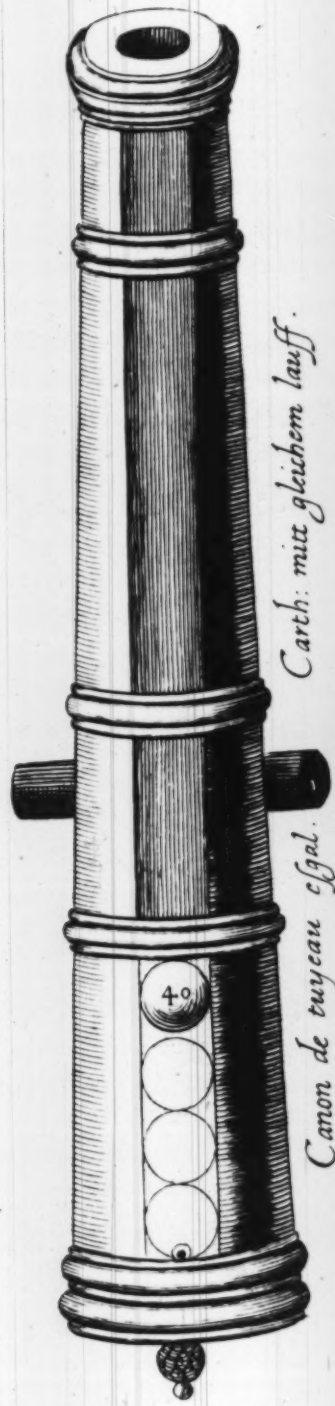
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Cap. 6. 4.



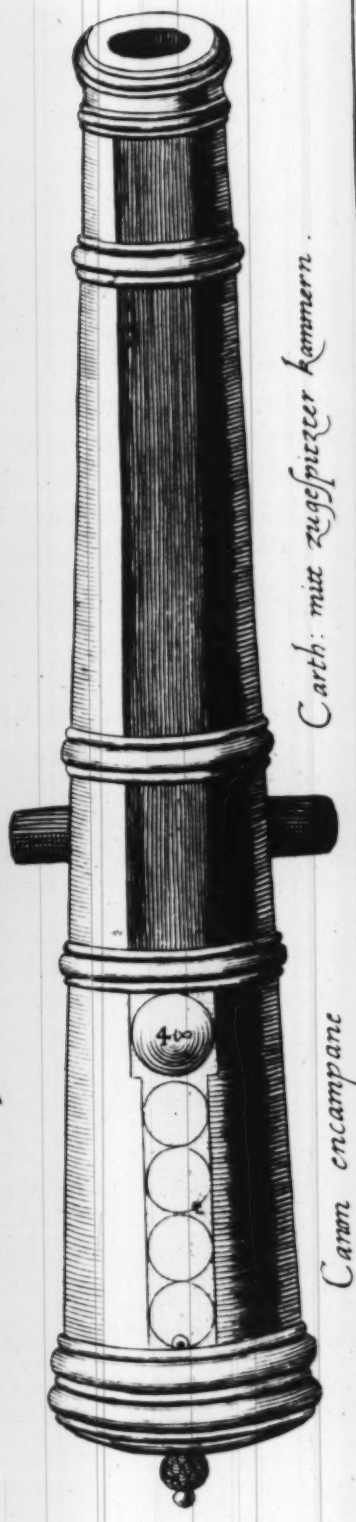
Carthau mit eingefenchter kammern.

Canon enchambre.



Carth: mit gleichem lauff.

Canon de tuyeau egal.



Carth: mit zugespitzter kammern.

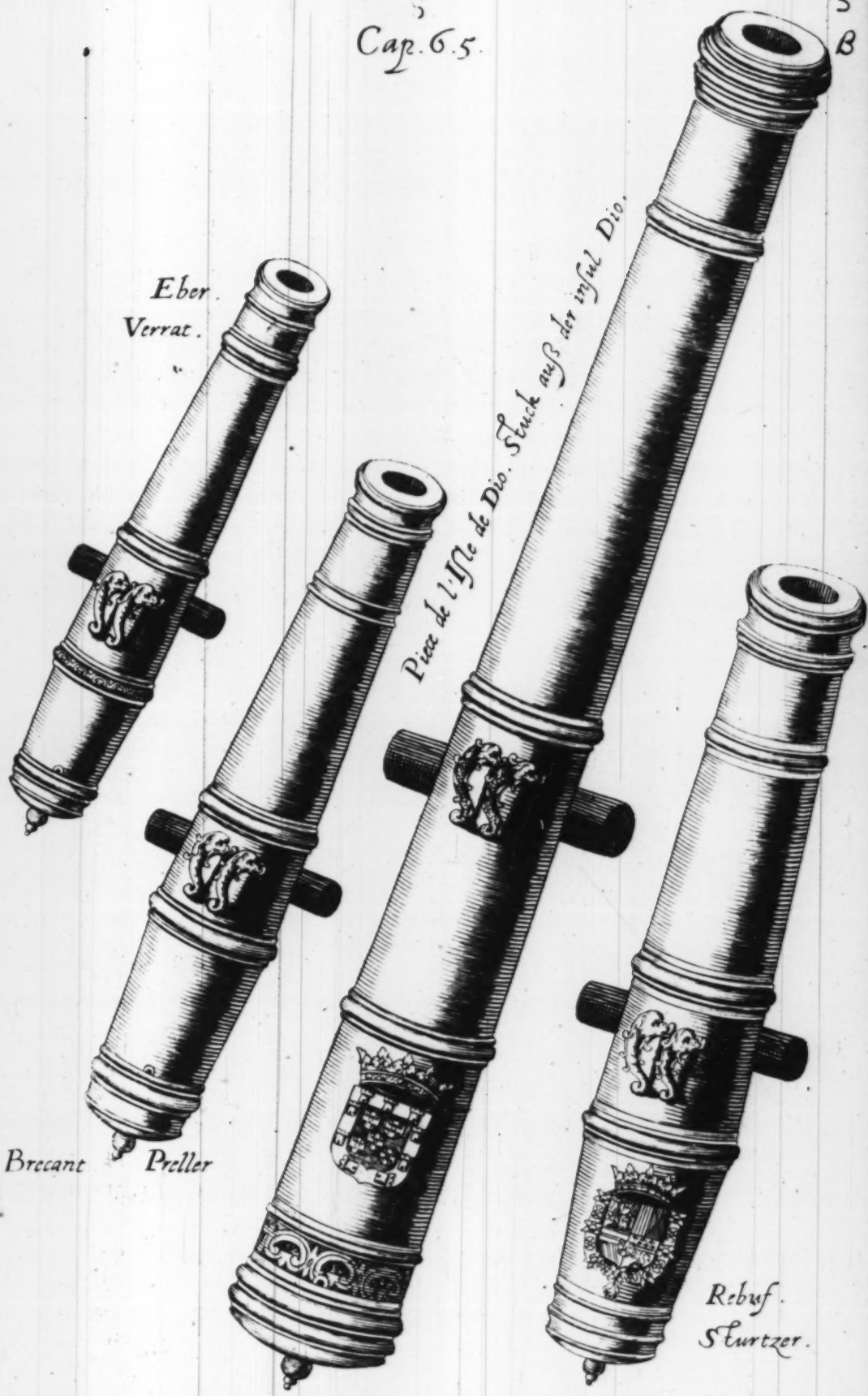
Canon encampane

Eber.  
Verrat.

Pice de l'Isle de Dio. Stück auß der insul Dio.

Breant  
Preller

Rebus.  
Sturtzer.



Carth: mit zugespizter kammern.

Cann encampare





CHAP. XIII.

Of the Cannon Periors and Perieraes, the third kind  
and their sorts.



Of this 3 kind are those Ordnance that shoote no Iron or Leaden shot, but only lighter, as Stone, Murthering, or Fire shot: of them there are foure especiall severall sorts. The *Canon Perior* being the principall, and therefore as the *Canon* of Batterie and *Culvering* bring the rest to be of their kinds, so for the same reason also may the *Canon Perior* doe the like for hers. The *Canon Perior* then, for the outside is not much vnlike vnto the *Canon* of Batterie, but that they are more vncertaine in the heights of their Calibers or Bores, some being higher and some lower in dyametre, It is a comely and a seruiceable Peece) and for those vses, namely to shoote Stone shot, they are well & sufficiently fortified, so that being duly loaden, the Gunner may therewith safely serue to defend a Breach, keep a passage, murther, and spoyle the Enemy being approached neere hand. Most foreigne *Canon Periors* are Chambred, being eyther taper or belbored in their Chambers, the Mouth of which Chamber being but eyther  $\frac{1}{2}$  or  $\frac{3}{4}$  in Calibre of the height or Calibre of the Mouth of the Chafe, of the Peece, the difference of which at the Mouth of the Chamber is called the *Orloe* or *Relish*, their Chambers are to be in length 4 Dyameters of the Mouth of the said Chamber. But the most of our English *Canon Periors* are equall bored through the length of their whole Chafes (which I conceiue were better to be onely taper bored in their Chamber) so as that the Mouth of their Chambers be equall in height with all the rest of her Calibre or Bore forward, towards her Mouth, because it will be thereby the better fortified in the Chamber, and so the more able to resist the force of her due loading in powder: these Peeces are to shoote the  $\frac{1}{2}$  of the waight of their Stone shot in corne powder, onely abating proportionally 5 pound of powder for euery 100 pound waight of shot. The Chambred *Canon Periors* with Relishes (as aforesaid) are troublesome to load, for that they are therefore to vse a *Scafetta*, and a Rowling Rammerhead, with a shiuer in the Staffe.

The length of these *Canon Periors* are about 8 Calibres of their Bore at the Mouth of the Chafe: they are to be in their Chambers  $\frac{1}{2}$  in thicknes of Mettall at their Touch-holes.

The *Perieraes* are the next sort of this third kind, which are in all things like vnto the *Canon Perior* (already mentioned) but that they are much poorer and weaker fortified with Mettall, being allowed for the *Canon Perior*, 80 pound of Mettall for euery pound waight of their Stone shot, and but 60 pound for the *Perieraes*, whose Chamber being but  $\frac{1}{2}$  in Bore of the Calibre at the Mouth, must be loaded with but  $\frac{1}{2}$  of Corne powder, but if it bee  $\frac{1}{2}$  then with  $\frac{1}{2}$  of the Stone shot waight.

The third sort of Ordnance of this third kind being the *Port Peeces*, and

*Stocke Fowlers* which are Brasse cast Peeces open at both ends, inuented to be loaded with Chambers at the Breech end, fitted close thereinto with a shouldring, euen as the wooden Trees for water pypes haue tapred ends to let them close one into another; The shot and wadde being first put into the Chase, then is the Chamber to bee firmly wedged into the Tayle of the Chase and Carriage. Now in stead of round Trunnions, there are 4 square tennants cast ioyning with the side of the Chase of the Peece, on eyther side two, which being let into the Block or Carriage, holdeth the whole Chase fast therein, leauing the Cornish lying vpon the ledge of the Ships Port, or vpon the *Mounture* in a Fort, and tryced vp with a rope fastned about the muzzle; The Tayle of the Carriage is to rest, and to be shored vp with an vp-right post or foote, full of holes to slide vp and downe in a square Mortice fitted thereunto, hauing a shiuer at the lower end thereof, with two Tressle legges mortized before vnder the blocke of the Carriage, the foote with holes hath a pinne to stay the Peece vpon any Mounture assigned. The fourth sort of this 3 kind are the Slings and Portingale Bases which haue Chambers fitted into their Breeches as the Stocke-Fowlers haue, but that the Tayles that stayes their Chambers to wedge them fast (as in one continued Peece of yron whereof they are vsually welded and wrought) vnto the Tayle whereof there is a long sterne handle of iron to direct them to respect the assigned marke: They stand vpon a forked Prop or Pintle vpon the ends of which the Trunnions resteth, they are loaded with their Chambers as the Stocke-Fowlers are: these shoote eyther Base and Burre, Musket or any other kind of Murthering Shot, being put vp in bagges or Lanthornes fitted to their Calibres. And being discharged, their Chambers are to bee taken out and fil'd againe, and othersto be put in ready charged in the place thereof. These Peeces are vsually loaded with  $\frac{3}{4}$  or  $\frac{1}{2}$  of the weight of their shot in corne powder. *Port Peeces* and *Fowlers* are vsually made of Cast Brasse, but *Portingall Bases*, *Slings*, and *Murtherers*, are commonly of wrought iron; the lengths of the Portingale Base is about 30 times her Calibre; the Sling about 12 times, the Murtherers, Port Peeces, and Fowlers 8 at the most besides their Chambers, their Chambers about 3 times their Calibre in length, and weigh the 6 or 8 part of the whole Chase.

*A Table concerning Chamber Peeces.*

|             | Length                    | Height                   | Powder              | Stoneshot               | & waigheth                |
|-------------|---------------------------|--------------------------|---------------------|-------------------------|---------------------------|
| A Cham-ber  | 13 inches & $\frac{1}{2}$ | 4 inches & $\frac{1}{2}$ | 7 lb.               | 6 $\frac{1}{2}$ inches. | 13 lb.                    |
|             | 23 inches & $\frac{1}{2}$ | 4 inches $\frac{1}{2}$   | 7 lb.               | 6 inches.               | 10 lb.                    |
|             | 24 inches                 | 4 inches $\frac{1}{2}$   | 9 lb.               | 7 inches                | 17 lb.                    |
|             | 17 inches & $\frac{1}{2}$ | 3 inches $\frac{1}{2}$   | 5 lb.               | 5 inches.               | 9 lb.                     |
| A Sling ch. | 23 inches                 | 2 inches & $\frac{1}{2}$ | 3 $\frac{1}{2}$ lb. | 2 inches $\frac{1}{2}$  | 2 lb. $\frac{1}{2}$ iron. |
| A Port ch.  | 16 inches                 | 3 inches $\frac{1}{2}$   | 3 lb.               | 5 inches $\frac{1}{2}$  | 9 lb. stone.              |
| A Base ch.  | 9 inches $\frac{1}{2}$    | 1 inch $\frac{1}{2}$     | $\frac{1}{2}$ lb.   | 1 inch $\frac{1}{2}$    | 6 oz. iron.               |

CHAP. XIII.

Of the fourth Kind of Ordnance, Short Gunnes, Mortars,  
and Square Murtherers, Pettards and Tortles,  
and the sorts thereof.

**M**orter Peeces, Square Murtherers, Tortles, and Pettards are the sorts of the fourth kind of Ordnance, and doe much differ from the former 3 kinds, and in many things also one of them from the other, as may appcare by the severall discourses vpon their descriptions and vses. The *Morter Peeces* are of severall grandures and fashions, for some of them are made to shoote a Stone shot of 350 pound waight, and some again are so small that their shot waigheth not about 4, 5, or 6 pound, and may be of any quantity betweene. And some are of one Cillinder without syde, others are of two, one of them lessened without as farre as their Chamber reacheth but all of them are Chambred, or as some Gunne-Founders tearme it *Cambred* taperingly, being at the Mouth of the Chamber about the Calibre of the Dyametre of the Mouth of the Peece, and in length thereof or more as the Chase is longer.

These *Morter Peeces* are of great efficacy, as well for the Assaylants as the Besiedged or Defendants: for being duely vsed, they much terrifie & trouble the Enemy besieged in a Towne, City or Fort; especially by sending vpon them Granadoes either single or double, or great iron stone or leaden shot, and from within when the Enemy should worke, or would rest in their Tents and Lodgings, whereunto by reason of some Hill, building, or Wall, they are so hidden that none other Ordnance can bee bended against them; for that all other Gunnes relye principally to conuey their shot in a right line, to doe effectuall seruice, whereas this sort worketh altogether in oblique or crooked lines vnlesse the Peece be mounted to 90 degrees, mounting them commonly about 45 degrees: namely to 60, 70, 80, and sometimes more or lesse, accordingly as the nature of the seruice requireth. But for the Defendants, these are ordinarily vsed to shoote forth Fire Bals into the Champion in the night, that they within may see what the Enemy worketh abroad; or els when the Enemy is approached vnto the foote of the Wall, to vndermaine or pierce it, or to enter a Breach already made, & cannot be well repulsed by other meanes or cannot be offended from aloft, shooting out of a Morter or other Perior, Bals of stone, old iron, or any other murthring shot or granadoes and Fire-workes. Some of them haue their Trunnions in the midst, other more aft, and some euen with their Breeches being fortified with mettall about the height of the Mouth of the Chamber at the Touch-hole, and of that Calibre at the Mouth of the Peece; They are of severall lengths in Chase, for some are two, and others are three Dyametres of their Mouthes Bore in length. They may bee loaded either with Car-  
touches



touches or with loose powder, allowing  $\frac{1}{10}$  part of the weight of the Shot, shooting vpon any mountaine about 40 degrees, but with  $\frac{1}{2}$  shooting leuell or downewards, alwayes putting home a good wadde betwene the Powder and Shot vnlesse it be a Fire-ball, which the Powder in the Peece is to fire in her discharge; for then the Fire-worke must lye in the loose powder, and haue a wadd before it, and some vse for euery hundred the Shot weigheth proportionally to abate 5, which *Alexander Bianco* liketh not: The proportion for loading them must be ordered according to the strength of the Peece and Powder, and waight of the Shot, and is also accordingly as the Mounture and distance is more or lesse, if the Shot bee a *Granado* made of Potters earth baked, or of *Glasse*, the  $\frac{1}{10}$  part of their weight will be sufficient powder to blow them out with little or no danger of breaking: for if they should haue so much powder as that the Ball is forced to breake within the Peece; or if any piene-hole or vent should chance to be in a mettalline *Granado*, so as that the powder within it be fired; the Peece would not onely breake and teare the carriage, but also endanger him that giueth fire, and frustrate the seruice: As was prooued by M. *Kennius* indiscreete practise in his late Maiesties *Mortier Peece*, breaking it, and also thereby indangering the spectators; wherfore if the *Granado* be of cast mettall, it were best to be couered ouer with the ordinary coating, to stop such vents as is hereafter mentioned: Then will  $\frac{1}{10}$  part of the weight of the Shot in corne powder be sufficient. But if it bee loaded with a solide Stone shot, then; or; rather of the weight thereof in corne powder may be allowed, the more powder, the lesse mounted, as we haue already said.

Now hauing shewed the proportion of powder, fitting each sort of Shot and Mounture, it will not be amisse to shew how to order and mannage the same Morter-peece, Gunner-like.

First then the Chamber is to bee well sponged and cleansed before the putting in of the powder, whether you load it with loose powder or Cartouch turning the Mouth neere vpright, the powder being so put into the Cháber, ther must be a wad put in either of hay or Okam, & after a Tampkin of Willow or other soft Wood; such as may, together with the powder that was first put in, fully fill vp the whole Chamber thereof, that there may bee no vacuity betwene the powder and wadd, or wadd and shot; after which the shot shall be also put in at the Mouth with a wadd after it; especially if the Peece be not much mounted, least the shot goe out too soone, and the wadd between the Tampkin and the Shot, is not onely to saue the shot from the Tampkins breaking of it, but also to auoide vacuities, which are very dangerous for the Peece by second expansions.

Hauing then resolued vpon the premisses concerning the Peece, Shot, & Powder, as before is shewed, and vpon the distance and Mounture for the Marke, as hereafter the Rules and Tables following shall direct; then for the bending and disposing it to the assigned seruice: Obserue first to lay a straight Ruler vpon the mouth of the Peece, and vpon it place a Quadrant or other Instrument crosse-wise to set the Peece vpright to auoide wide shooting, and then placing them fore-right to eleuate it into the resolued degree of Monutire to auoide short or ouer shooting accordingly, as the Tables and examples following will leade you: for hauing made one shot, you may thereby

thereby proportion the rest, considering whether you are to shoote with or against the wind, or whether it blowe towards the right or left hand, and whether weakely or strongly; and so accordingly to giue or abate the advantage or disaduantage: which iudgement, not Rule must induce, and yet by helpe of the Notes following, of mine owne experience late made in one of his Maiesties Morter Peeces, and by these Tables, any iudicious Gunner may with a Shot or two first made out of the Peece hee with practise may very much helpe himselfe.

Captaine Vffano his Table for a Morter Peece to shoote there-  
with by the twelue Poynts of the Gunneers  
Quadrant. And

| Poynts | Paces | Mine owne Notes of practise in a Morter peece that shot a stone<br>shot of 4 inches in Dyametre high. The Morter Peeces Chamber be-<br>ing 1; inches at the Mouth therof, and three inches deep, and the rest<br>of her Chafe being 10 inches deepe, which I discharged with three<br>ounces of powder there being little wind. |       |        |
|--------|-------|---|-------|--------|
| 0      | 100   |   |       |        |
| 1      | 248   |   |       |        |
| 2      | 377   |   |       |        |
| 3      | 468   |   |       |        |
| 4      | 534   |   |       |        |
| 5      | 570   |   |       |        |
| 6      | 583   |   |       |        |
| 7      | 566   |   |       |        |
| 8      | 532   |   |       |        |
| 9      | 468   |   |       |        |
| 10     | 377   |   |       |        |
| 11     | 243   |   |       |        |
| 12     | 000   |   |       |        |
|        |       | degrees   | yards | Shores |
|        |       | At 45   | 750   | 37½    |
|        |       | At 50   | 710   | 35½    |
|        |       | At 55   | 675   | 33½    |
|        |       | At 60   | 620   | 31     |
|        |       | At 65   | 575   | 28½    |
|        |       | At 70   | 480   | 24     |
|        |       | At 75   | 360   | 18     |
|        |       | At 80   | 270   | 13     |

A Table out of Vffano for the Morter Peeces, Randons made  
for euery degree betweene the Leuell and 90 degrees.

| degr. | paces | degr. | gr. | paces | degr. | degr. | paces | degr. |
|-------|-------|-------|-----|-------|-------|-------|-------|-------|
| 0     | 100   | 89    | 16  | 393   | 73    | 31    | 539   | 58    |
| 1     | 122   | 88    | 17  | 406   | 72    | 32    | 543   | 57    |
| 2     | 143   | 87    | 18  | 419   | 71    | 33    | 549   | 56    |
| 3     | 164   | 86    | 19  | 432   | 70    | 34    | 552   | 55    |
| 4     | 185   | 85    | 20  | 445   | 69    | 35    | 558   | 54    |
| 5     | 104   | 84    | 21  | 457   | 68    | 36    | 562   | 53    |
| 6     | 224   | 83    | 22  | 468   | 67    | 37    | 568   | 52    |
| 7     | 243   | 82    | 23  | 479   | 66    | 38    | 573   | 51    |
| 8     | 262   | 81    | 24  | 490   | 65    | 39    | 477   | 50    |
| 9     | 280   | 80    | 25  | 500   | 64    | 40    | 580   | 49    |
| 10    | 297   | 79    | 26  | 510   | 63    | 41    | 582   | 48    |
| 11    | 314   | 78    | 27  | 518   | 62    | 42    | 583   | 47    |
| 12    | 331   | 77    | 28  | 524   | 61    | 43    | 584   | 46    |
| 13    | 347   | 76    | 29  | 529   | 60    | 44    | 582   |       |
| 14    | 363   | 75    | 30  | 534   | 59    | 45    | 582   |       |
| 15    | 377   | 74    |     |       |       |       |       |       |

*The vse of the former Table.*

The vse of the Table may bee thus explained. Having once made knowne the distance the Peece did shoote at any Monutire giuen. As for example: suppose at 53 degrees which conueyed the shot 700 paces, and you desire to know how far she would shoote at 60 degrees: Now because 700 degrees is not at all in this Table, but against 60 degrees there standeth 529 paces. Therefore say by the Rule of 3, if 562 the number against 53 degrees giue 700 paces, what shall 529 the number against 60 degrees giue, multiplying 700 by 529, and diuide the produ& by 562, and the Quotient will be 649  $\frac{1}{2}$  fere, the number of paces which the said Morter Peece will shoote at 60 degrees Monutire being alike loaded, and hauing such like accidents as it had when it was shot off at 52 degrees, and so for any other number of paces or degrees, or distances assigned.

The second sort of this fourth and last kind of Ordnance, are the *Pettards*, which are short Peeces of late yeares deuised and practised to make ouertures into Townes, Cities and Forts by breaking open their Ports & Gates, and blowing vp of Bridges and Walls by meanes of the force of powder fired. Of these there are of seuerall formes and magnitudes, euen as they are of seuerall vses and for different seruices; especially in greatnes when great force is requisite. Some of them are cast in shape not much vnlike the fashion of a Grocers or Apothecaries Spice Morter, and some are tapered much like a Coopers water payle, little deeper then the Dyametre of their mouthes, but being not about  $\frac{1}{2}$  in Dyametre at their bottome or breech of their mouthes Calibre, and in thicknes of mettall  $\frac{1}{2}$  of the Dyametre at their breech, and lessening in thicknes towards their mouths. Their magnitudes are some to hold but one pound of powder or lesse, and others to hold 50 lb. or more, and they vsually allow 4 lb. of Brasse, or 5 lb. of iron to cast a *Pettard* for one pound of powder, and 250 pound of Brasse, or 300 pound for a *Pettard* that shall hold 50 pound of powder, vsing those proportions diminished for lesser, and augmented for greater. The *Pettard* is sometimes to be vied in places accessible and inaccessible. Suppose then we are to *Pettard* a Port or Gate vnto which we may approach, in that case a skrewed hooke is to bee let into the Port, vpon which the *Pettard* with her *Planchier* or *Matria* is to be hanged, as in the 13 figure at *A* is representd.

The *Planchier* is, at least to be 3 inches thick, arm'd with irō plates to defend it from splitting, it is also to be vnderpropped with the forked Rest, & stayed in the ground at the hinder end to hinder the reuerse thereof. *Pettards* are to be loaded with fine corne powder, the finer corned the better being very hard beaten in, by little and little at once with iron Drifts or such like, of the iust height of the Dyametre of each places concave of the *Pettard*, vntill it be full within one finger breadth of the top, and then some vse to make a hole through the powder vnto the bottome with a pyke head or such like, into which hollownes they put incertaine quills filled with raw quicke-siluer. Lastly, they couer the mouth thereof with a waxed cloath, being cut of the iust breadth of the inside of the mouth of it, & fill vp also the rest that is yet empty with molten waxe, mingled with hempe cut, or with tow rather. They are





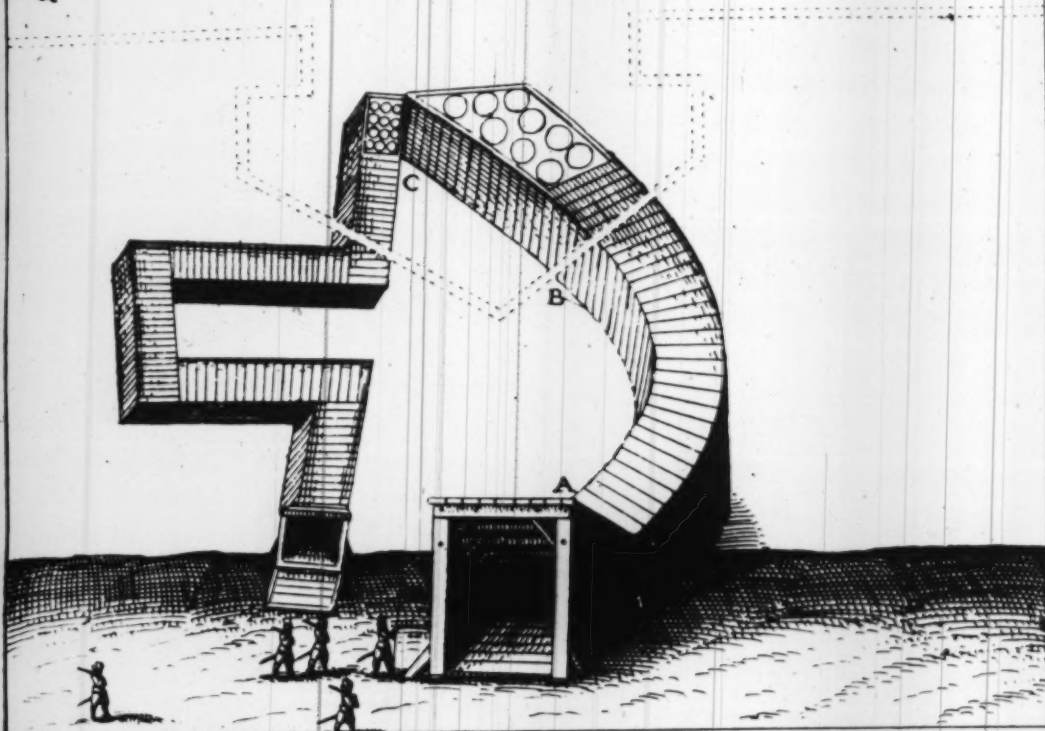
Comment il fault armer et conduire vne mine.  
 • Wie eine minen zu leitten vnde zu verwahren.

α

Traët. 2. Cap. 3.

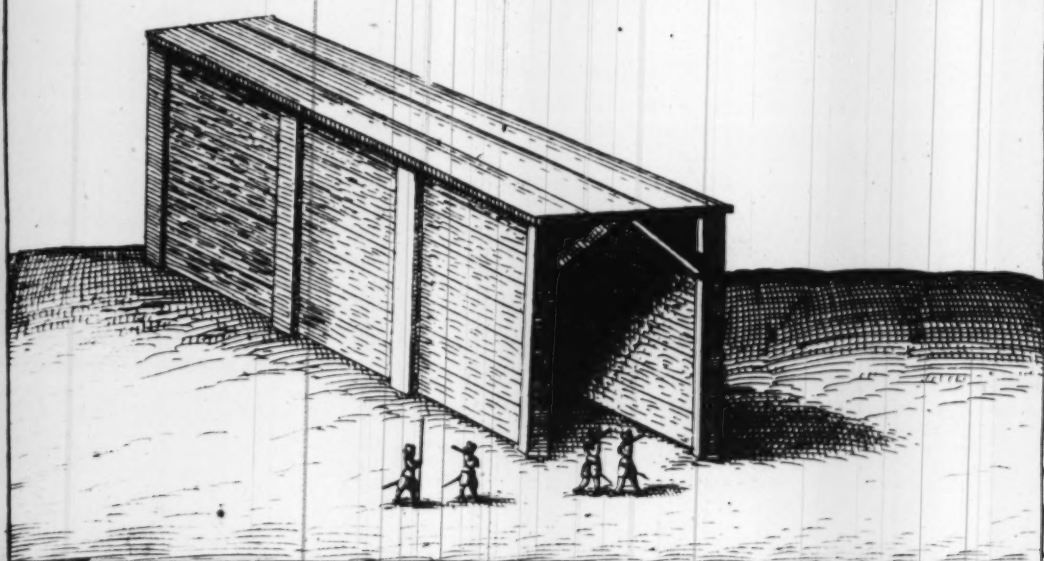
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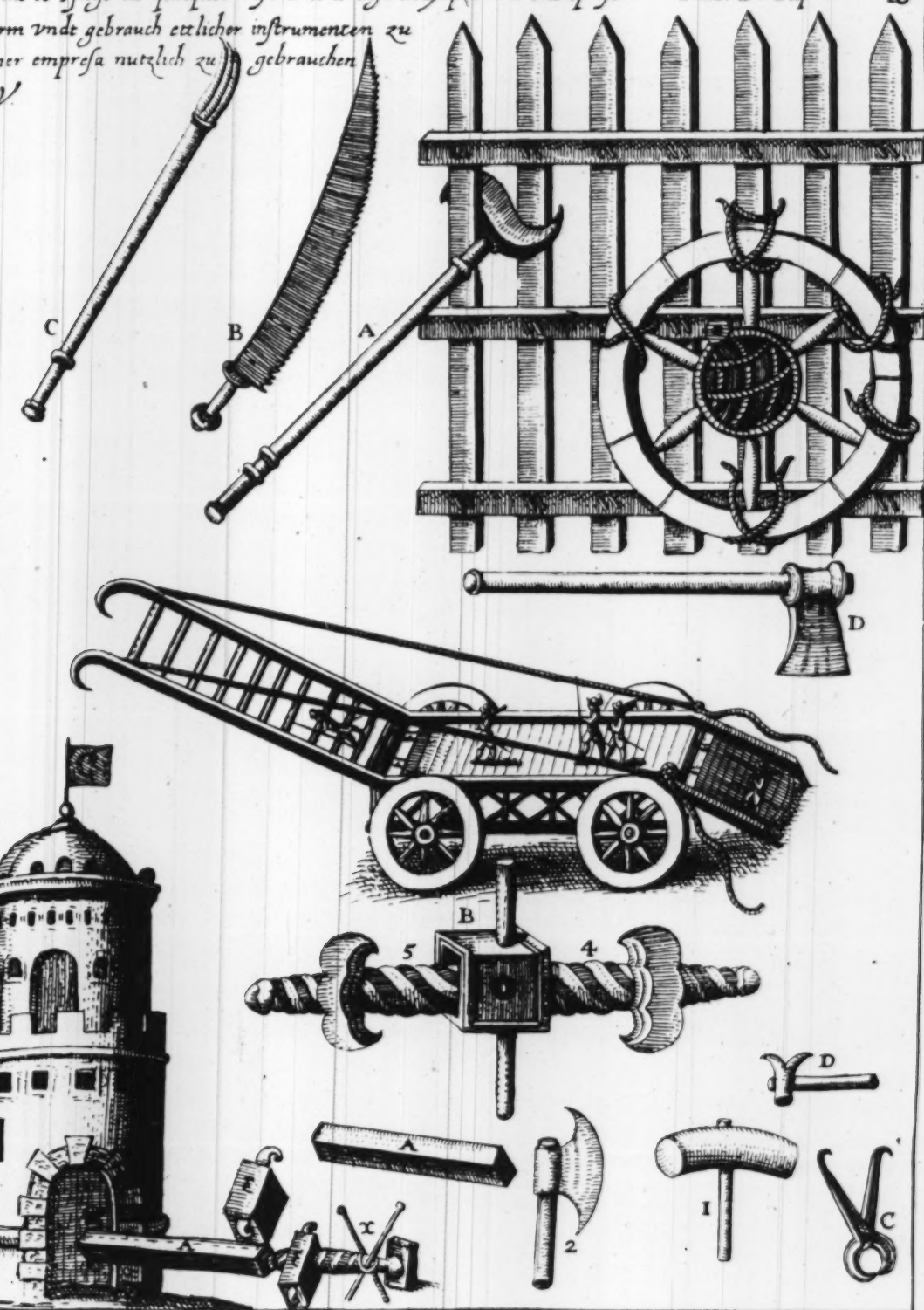
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B

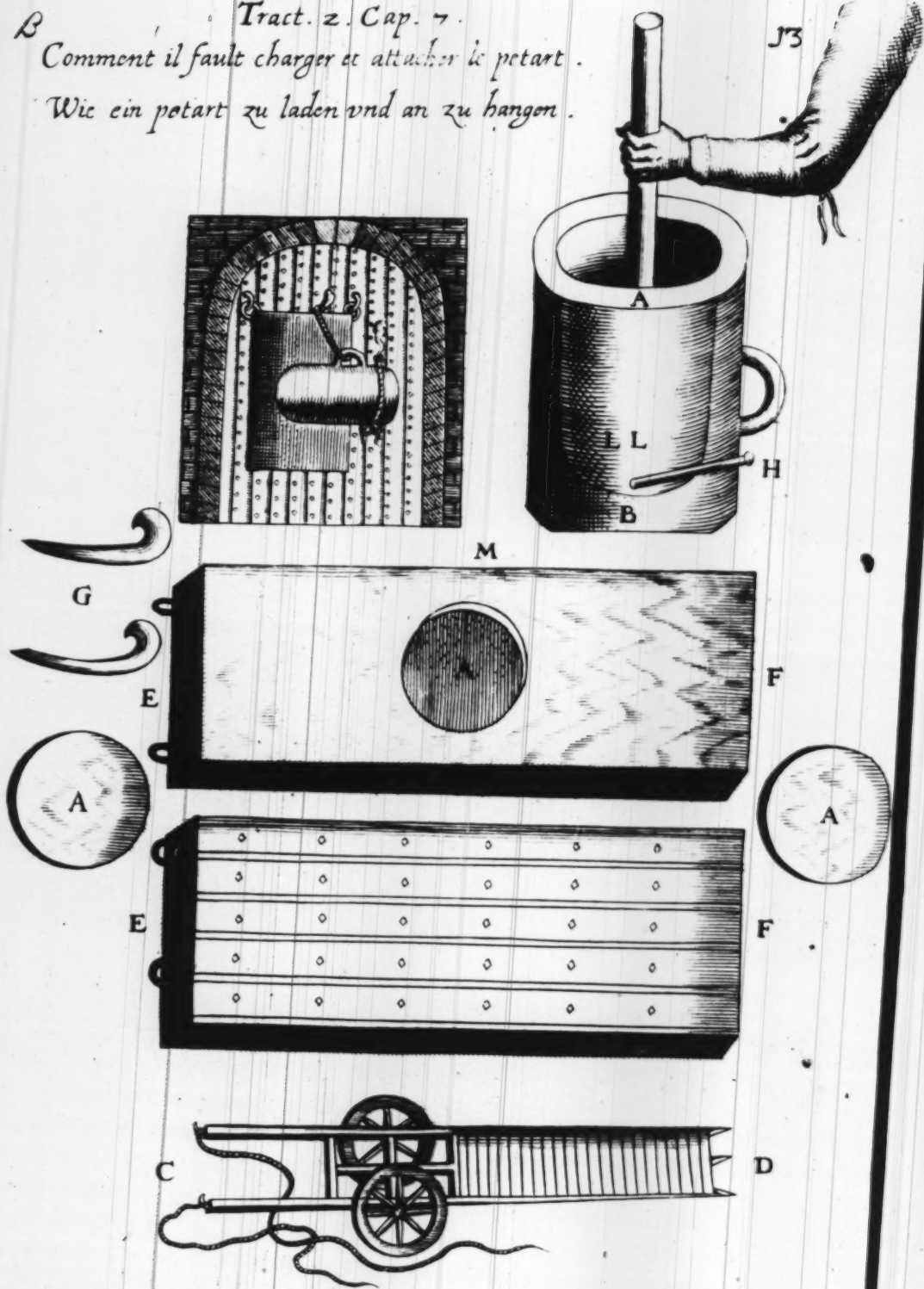
galerie.







Tract. 2. Cap. 7.  
*B* Comment il fault charger et attacher le potart.  
 Wie ein potart zu laden vnd an zu hangen.



are to haue a socket and backstay for the vnderproppe, and a pype ouer the Touch-hole which must be filled with slow and sure receipt of Fireworke, to the end that the *Pettardier* hauing by a pryming of quicke powder giuen fire the reunto, and retired for his safety, wherein he must be carefull to auoid retyring in the right line of her reuerse, for feare of danger.

But if we be to *Pettard* a *Port* vnto which wee cannot approach to hang the *Pettard* thereon, then make a little wooden horse with 4 wheels or Trucks lyned with Cloath or Wooll to auoide making noyse, the Handle whereof is to carry the said *Pettard*, being at the least 40 foote long, with a Counterpoize at the other end, hauing the *Planchier* fastned close before the mouth of the *Pettard*, with the crochet or vnderprop to place the same as close and flat against the *Port* as is possible, and the aftmoost end of the *Staffe* or prop made firme against some stake in the ground (to stay the reuerse) so alwaies that it belong enough to reach ouer the dike or drawbridge to be driven close, that the *Pettard* may be firmed against the Gate. Then so loded and fire giuen to the slow vent or pype with the slow receipt, the re-trait may haue time to be oblikely made, least her reuerse supprize the *Pettardier* before he can get out of the danger therof. The figures and discourse following as well for the accessible as for the inaccessible Ports here annexed, will make that which we haue said the better vnderstood.



## CHAP. XV.

*Of severall wayes to prevent the effectuall working of Petards.*



**D**ivers and severall meanes there are also to prevent the placing and effectuall working of the said *Petards*: whereof a word or two in briebe. The first is by a kind of strong iron Gridiron or Grate so placed before the Port, somewhat distant, as 3 or 4 fecte off, that the *Planchier* of the *Pettard* cannot come close enough to the Gate: for that the Ayre betwene it and the *Pettard* will doubtlesse make the action therof to be of little or no effect: otherwise to spoyle the *Pettardier* and *Afsistants* neere, a fall-trap being let go with a buckle tricked when the *Pettardier* shall either tread vpon a draw-bridge or bord covered with earth, which will pull out the buckle, and so it will let a great circle with iron works by a spring fall violently vpon his head; likewise they impeach the hanging and propping *Pettards* by certaine points of iron about 3 fecte long placed vnder the Draw-bridge, which when it is drawne vp, stands out and impeacheth the placing of them against it. In like sort by a trap-draw-bridge which will fall downe as soone as the *Pettardier* shall tread thereon, and slide him and his *Pettard* into the dyke; so also if a paire of compasses of iron with teeth on the legges haue their head with a ioynt fastened aboue to the stone worke of the Port, so that as soone as the bridge or bord which holds the compasses and teeth open, is vnloosed by treading thereon, they are forced together by strong springs most violently, which terribly will claspe and teare him in most miserable manner. Another is by two semicircles with sawteeth to claspe together as soone as the *Pettardier* sets foote on the false bord or bridge to vnitch the springholds. Also a cord being fastned to the outmost end of the loose bridge, which by the *Pettardiers* stepping thereon, vnlooseth the hold, so a number of stones will thereby all fall on his head and beate out his braines. So also a false Port with 3 or 4 feet or more of vacuitie betwene it and the true Port, rising higher then the true Port in greues hoisted vp as a Percullis, and shall fall when the *Pettardier* steppeth on the false bridge; likewise by a false or loose bridge which shall pull a tricked that shall let downe a snaphance, and giue fire vnto 20 or 30 loaded muskets, whose mouthes shall be scene through the Port, and discharge themselves vpon the *Pettardier* and his *afsistants*. As the figures in the 6, 7, 8, 9, 10, 11, 12, and 13 Chapters of the second book intituled *Recuil de plusieurs Machines militaires* will more manifest vnto the eye.



## CHAP. XVI.

*How and with what instruments you may breake the Pyles  
Palefadoes, Grates, Percallises, and Chaynes, or such like  
iron or wood-worke to lay them open for entry.*



O breake *Palefadoes, Grates, Barres, and* such like enclosures of any Towne, Castle, Fort, or *Redoubt* house. The instrument that is noted with *A*, which is a wrench that being aplied and fastned as the figure sheweth, will reare open strong Bars, Or the Saw *B*, in sawing alunder the ioynts, Or the Crow *C*, whose Clauen tooke being gotten betweene the *Joynes*, will forcibly disioyne them, Or els Axlike wedge *D*. But if the enterprize bee to be secretly executed without noyse of strokes of tooles, then a fire wheele in such manner fastned, prymed and fired, and fixed as the figure sheweth, will soon make way, if it be wel ordered, for the purpose, as hereafter in this Chapter shall be directed. The same instruments are to be aplied vnto *Barres* of Gates, of Townes and Castles, if they may be approached secretly. For else there can bee no better way to make ouerture then by battery with great Ordnance, which from far will soone make a breach aswell in Ports which are vsually fortified with barracadoes and other defences, but may be therby soon battered to make sufficient breach to enter by, yea were it in bulwarks or Curtins as hereafter shall bee shewed more at large. If you would force a great Port of a Towne secretly, there is another meanes besides the *Pestard* already spoken of, namely the Skrew Nut marked *E*, and his skrew-barre *A*, with which in turning the winlase *X*, it will soone breake open the Port, so that the backstay be fast and strong enough. Now if it be strengthened with chaines of iron within, although they were great and strong, yet by the skrew spindles *4* and *5*, turning the Nut *B*, by the winlase & spykesthereof, and so in like manner the iron *Bars* and *Grates* may be broken asunder or pulled out with the *Pinchers* *C*, and the drawing hammer *D*, and the mallet of hard-wood *I*, and the short Axe-wedge *2*. Next to those instruments the drift bridge betweene them represented was iouented to reach over a dyke and to put any Towne or Fort to the Scalado, it is not much vnlike the Cart-bridge vsed for the *Pestard*, as before may be seene in his Chapter, but that it is not so great and heavy as it.

## CHAP. XVII.

*How to Dispart any Peece of Ordnance that is truly and  
equall bored in the middest of the Met-  
tall thereof.*



All things belonging vnto a Gunner, the chiefest is to bring the Mettall of his Peece euen, which the Gunners call disparting: wherefore the dispart for any Peece of Ordnance, whose concaue Cilliorder or Bore lyeth equall and truly in the midst of her Mettall, is nothing els but to equall the difference betweene the thicknes of the mettall that the Base Ring hath in Semidiametre more then the semidyametre at the Muzzle Ring, without which equall difference applyed vpon the vpmost of the mettalls on the Muzzle Ring eyther had (or guessed at with discretion,) it is impossible to direct a Peece to any marke, to make a shot to an assured good effect: The dispart is many wayes to bee found. First in such Peeces as are not Chambred by a priming iron, pur downe to the lower part of the Bore in at the Touch-hole, and making a marke vpon it euen in height with the highest of the mettall vpon the Base Ring, then carrying the same measure vnto the Mouth, and placing it vpright with the lower end of the priming iron iust on the lower part of the Bore there; Then looke how much the mark, so made on the priming iron, reacheth higher then the vpper part of the mettall of the Muzzle Ring, so much is the length of the dispart to bee placed vpon the highest of the mettall there: Or els taking the Dyamettes of the Base Ring, and also of the Muzzle Ring with a paire of Caliber compasses, or by guyrding or otherwise, and the halfe of their Dyamettes is the true length of the dispart to be placed vpon the highest of the mettall on the Muzzle Ring as is aforesaid.

As for example, suppose the Dyametre of the Base Ring to be 24 inches, and the Dyametre of the Muzzle Ring to be 18 inches, the difference is 6 inches, the halfe whercof 3 inches, is the length of the dispart sought. Or take the compasse in inches & parts at the Basering, and diuide it into 3 equal parts, and doe the like at the Muzzle-ring. And the halfe of their difference will be the dispart for any Peece that is truly bored. Or rather hauing guirded the Peece at the Base and Muzzle ring, looke how many times 22 quarter of inches are therein contained, so many times 7 quarters of inches doth the Dyamettes containe. And the halfe of the difference of those two Dyamettes is the due dispart sought. Or els take a Rule or staffe, and lay it crosse vpon the Basering of the Peece, and then take a lyne and plummet, and hold it that it may hang close: first to the one side of the Peece, and then to the other side thereof, marking also vpon the Rule or staffe, where the lyne toucheth at both times, that the string onely touch the sydes of the Peece without any bending, Then lay that Rule and Measure to the mouth: likewise looke what the ouer measure commeth vnto, take the halfe of that measure

measure for the due dispart. Now for Chamber Peeces, there can bee no certaine generall Rule giuen for their disparts: for they must be ordered according to the forme of the Chamber and oreloze or Hall of the Peece; whether it be *Sling, Base, Fowler*, or *Port Peece*. But euery discreet and vnderstanding Gunner, when he seeth the Peece, may by what hath beene sayde, know what to doe therein: for Port Peeces, and Fowlers they onely shoote stone, and not iron shot.

CHAP. XVIII.

Of certaine faults committed in Forreigne Foundings of Ordnance.



He industrious Gunner may by that which hath beene said, take true knowledge of all sorts of Ordnance, as well Antient as Moderne, and also vnderstand the reasons, grounds, and vses of them, and of any others which shall hereafter be seruiceably inuented, and so be able to iudge of the goodnesse and defects of any Peece whatsoeuer, to make choyce of the best, and in time of neede to make vse of the worst; yet it is not imposed vpon the Gunners Office to practize Foundings of Ordnance, although it bee one of the most necessary Sciences of these times in vse, which was neuer bred among the common sort of men, as other handycrafts were, for that they must not onely be conuersant and expert in the Mathematickes, but also trayned vp thereto from their childhood if they will be excellent for ready handines therein, which makes mee and others wonderously maruell, that so necessarie a science should bee no better respected amongst vs, and that that there is no more care taken to bring vp expert Founders of Ordnance for times to come, in this war-like age. But if we shall well examine the most vsed Foundings in *Europe*: namely, those of *Lisbon, Malaga, Barcelona, Naples, Sicillia, Cremes, Milan, Genoa, Venice, Molines* and *Vtrecht*: in which by reason of their continuall practise they might easily haue become excellent & expert, yet whether it be by negligēce ignorance, or els by the too much haste made by those that haue the charge and command of those Foundings, it is apparant that they commit great and absurd faults therein. Some of their Peeces (and not a few) are bored awry, their *Soule* not lying in the widst of the body of Mettall; some are crooked in their Chase, other of vnequall bores, some too light towards the Breech turne their mouthes downewards in their discharge, and so endanger their owne Vawmures and Defences: insomuch that my selfe and other good Gunners in time of seruice could hardly finde means to remedy that fault, eyther by hanging waight vpon the *Pommell* or *Cascabell*, or by wedging it vnder at the fore Transom of her Carriage: others are too heauy also in their Breech, by placing the Trunnions too much aftwards, that Coynes can hardly be drawne, but by the extraordinary strength to manage and weigh them vp behind, or lay her vnder mettall without putting a long



leauer in her mouth. Some and a great many Peecces are come forth of the Furnace spoony, or full of hony-combes and flawes, by reason that the mettall runneth not fine, or that the moulds are not thoroughly dried, or well nealed: whereby eyther the Gunner that serueth with them is much endangered, they being as bad or worse to serue with, as those that are too weake and poore in mettall: for if they be loaded with so much powder as is ordinary for those sorts of Peecces (as may often happen when such Gunners load them, as are either ignorant or negligent in examining their defects) they will either breake, split, or blowingly spring their mettalls, and (besides that mischiefe they doe) they will be made viterly vseruiceable euer after. Wherefore to auoyd those dangers & faults, Gun-Founders may do well to conferre one with another, and also with vnderstanding and experienced Gunners thereupon, who with the hazard of their liues haue often seene into those inconueniences: yet thus much I dare say to the due commendations of our English *Gunnfounders*, that the Ordnance which they of late yeares haue cast, as well for neatnes, as also for reasonable bestowing and disposing of the mettall, they haue far excelled all the former or forreigne aforementioned founders. But it is to be feared that there being so few of that profession here imployed for Founding of Brasse Ordnance, (only Mr. *Pitts* and his Brother, and Mr. *Philips*, and as yet so few or none brought vp to learne it vnder them,) as that it is like that hereafter there may bee a great want of honest and skilfull Gunnefounders in England, the inconuenience that els may hereafter so befall, I hope will bee foreseene and preuented in good time.

*Le Sieur du Praisac* in his 13<sup>th</sup> Chapter of his *Military Discourses*, aduiseeth Founders to haue a speciall care for the temper and Allayes of the mettalls, the inward cleannes of the moulds and nealing of them well, and to their Caps and Cauties to anoint them with cleane grease, and to guard and binde them well with iron, to dry them and settle them firmly, and for the due placing of the Trunnions, as is shewed in the 22 Chapter hereof, that they may so neerely equiballance one end with the other, that one Gunner with a Leuer or Handspyke may rayse or imbase it vpon her Cariage, eyther for the draining or putting in Coynes to direct them, or lay them vnder mettalls. The running of the mettall not fine or too cold, and the mould not well nealed, or the mettalls not well incorporated; either of these causeth flawes, crackes, spungynes, or hony-combs in the mettall of the Peece, whereby great danger often ensueth.

## CHAP. XIX.

Concerning the League and Alligation or mixture of Mettals  
to Found great Ordnance.



Or the Natural viscuosity, softnes, & dulnes of the colour of *Copper*, there hath for the Foundings of *Ordnance* beene many *Alloyes*, *Leagues*, or *Alligations* of other mettalls by severall Founders vsed as their diuers colours and tempers doe manifest. True it is, that the proper Alloy for *Copper*, is fine *Cornish Tinne*, when as you would haue your worke subiect to the Hammer, or els it will not be reduced to such subtilty; as to endure the fire, or to make vessells off. But when as it shall be accompanied as shall herein bee hereafter mentioned, it doth not onely change the name, also the aspect and Nature thereof, as to bee called Ordinary *Brasse*, *Bell-mettall*, or els *Brasse* for *Ordnance*, *Brasse* ordinarily is made onely by *Tinne*, *Copper*, and *Lapis Caliminaris*. *Bell mettall* with more *Tinne* and some *Latton*, for *Bells*, *Mortars*, and for *Ordnance*, As *Biringuccio* sayth, 12 pound of *Tinne* for 100 pound of *Copper*, for *Bells* 23 or 20 pound of *Tinne* for 100 pound of *Copper* to cause the better sound, and accordingly as they are to be greater or lesse, wherein I intend not here to giue any other Rule; but to mixe them by waight, and measure, as discretion and iudgement shall induce. But more particularly for *Ordnance*, I haue thought fitting to relate the opinions of such worke-masters and Authors as I haue receiued instructions from. *Ieremie Rosselli*, saith, that for 16 lb. of *Copper*, 10 lb. of *Tinne*, and 8 lb. of *Latton*, and that the *Tinne* giueth hardnes, and sothereth the *Copper* and *Latton*, and that the *Latton* giueth them colour together, adding the more force to resist the vehemency of the powder fired in them, so that they make the Peeeces that are cast of that mixture to be faire and strong. *Alexander Bianco* in his *Millitarie* saith, that the best Allegations of those Mettals for *Ordnance*, is for 100 lb. of *Copper*, 20 lb. of *Tinne*, and 5 lb. of *Brasse* or *Latton* is to be mixed. *Diego Vffano* in his *Instruction de Artillerie* sayth, that the best Legature for *Ordnance* is 100 lb. of *Copper*, 8 lb. of *Tinne*, and 5 lb. of *Latton*, and 10 lb. of *Sow-lead*, affirming that *Lead* being tough and cold, maketh it also become hard.

And *Sieur du Prissac* in his *Military* discourses saith, that the French Founders vnto every 100 lb. of *Copper* doe either adde 20 lb. of *Bell mettall*, (which is 25 lb. of *Tinne* and *Lead*, for 100 lb. of *Copper* or *Brasse*) or else 10 lb. of soft *Tinne* to each 100 pound of *Copper*.

## CHAP. XX.

*Of the Powders or Earths to make the Moulds to cast in  
Brasse Ordnance.*

Or the Foundings of Great Ordnance, there are special sorts of *Earths*, whereof the Moulds and Modells are compounded either to cast in Brasse or iron, whereof it behooveth to seeke the best, namely that are able to resist the fire and receive the melted mettalls, so that they may render them to bee cast and Founded neatly without being subiect eyther to be diminished, crackt or peeled when they shall be nealed, which is such a matter as without experience cannot be done well. The rather be cause that Earth in it selfe generally taken cannot safely be chosen, the colours thereof is no sufficient signe: for we see some earth to be white, some blacke, some yellow, and others red; and of each some are good, some bad. But none of them can by their colours be assuredly said or chosen for good in effect: for there may bee some of each of those colours good; yet all earths being eyther fat or leane, or soft, or grosse, or viscusous, whereof the leane soone turneth vnto dust, without holding together, which also are a long time drying, and are but of little continuance for strength. The Fat and viscusous Earths shrink and chappe, and doe soone breake by their naturall brittinesse, and doe often grow crooked by the vneuenesse of their mixture or temper, whereby they become crooked in the Mould, and so warpe the patterne it selfe: so that it is rare that such a Peece should come neatly or well out of the mould: Where upon we may conclude that good *Earths* are neyther Fat nor Leane, but betweene both, and of a fine and subrill graine or mould, which soone dryeth and remaineth firme, without breaking, being able to resist the vehemeney of the fire; and such *Earths* are most commonly of a yellow or red colour: but relying not vpon the colour, prooue the quality of your *Earths* with iudgement, and so will experience the *Mistrisse of Arts* be your best Tutour to direct you to the best powders, which must be the first foundation of your worke.

But to finde such as are fit for your worke, it behooveth you to sinke diggers pits or caues vnder ground, which haue not beene much stirred. And after you haue begun your worke, and compounded your *Earths* in a banke or heape, and wet and moystened them like a paste, begin then to beat them with a rod of Iron, as the Potters vse to doe their Claye. Then take two third parts of the whole quantity, and mixe it with lynt of Linnen-cloth and then beate the same againe together vntill they bee well incorporated, that they may appeare all one substance, and if any small stones should chance to fall amongst it to pickethem out or bruisse them as small as may be thereby, and so the powders being well tempered may serue for your moulds and formes.

Some if they cannot haue such *Earths* as they would, content themselues, with



with such as they can get, which when they haue tempered into paste, they dry, and then beate and remoysten; others mixe it with burnt sand and ashes; others hauing but weake *Earths*, temper them with water wherein burnt salt is dissolued, mixing therewith Scales or Lymmel of iron finely beaten and searced.

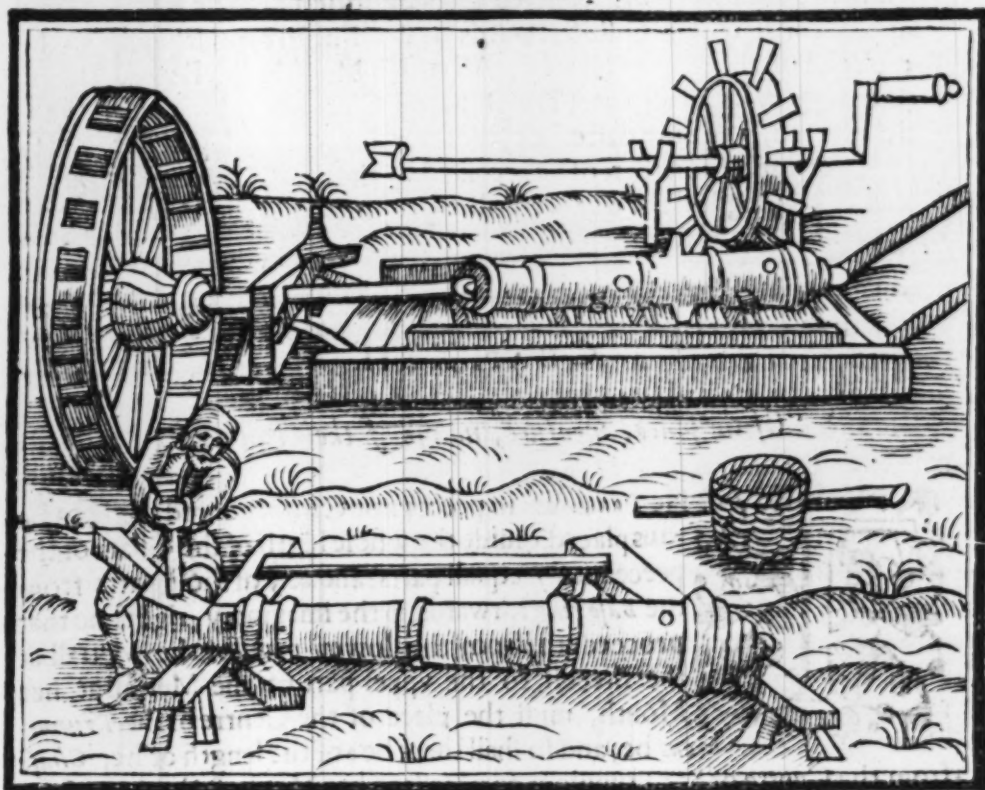
And lastly, some mixe therewith Horse or Oxe dung, and some vsed sedge and straw finely chopt and mealed, each to his best liking, endeavouring to prevent the ill accedents that may hinder the good successses of their workes.

CHAP. XX.

*Of making of Moulds for the Founding of Ordnance.*



Each Workemaster in any Art whatsoever, holdeth alwayes eyther the way wherein hee hath beene taught, or els that which in his iudgement and vnderstanding hee thinketh to be the best: Euen so is it with Gunne-Founders, who notwithstanding the meanes that they vse in Foundings are diuers and many, according as they are either great or small, yet almost all tend to same end.



And having so prepared and resolved of what kind, and what sort of that kind the Ordnance is, you intend to Cast you are then first to make a Modell or perfect patterne thereof, eyther of Timber, or of Earth (or both) with all the Mouldures, Ornaments, and Compartiments, even as you would have the Peece to be, which you must thinnely anoynt with soft hogs grease, and then couer it ouer with a Colume of the aforesaid tempered earth, made and dryed by little and little, augmenting it vntill it bee of a competent strength & thicknes; This Colume must be to betaken into two or more parts, to the end to take the said Modell or patterne out of it, and it is to be fortified on the out side with Plates of iron as long as the Chafe of the Peece, and with iron wyres an inch each from other, and lastly with iron hoopes a foote or two asunder, to knocke off and on as occasion shall require. There must also bee a smooth and equall Cillinder, whose Diameter must be iust the height of the Bore, and made of the same earth moulded vpon a strong Iron square Barre, and vpon a cord wound about the same, therewith to make the soule or concaue hollow Cillinder of the Peece, by placing it (by helpe of the Base and Muzzle-ring) exactly in the midst of the vacuity of the outermost Colume, which when the Patterne or Modell shall bee taken out, will remaine hollow to receiue the mettall that must make the body of the Peece. All these must be well ioyned red together, polished smooth, and dryed and nealed, that the mettall be-  
 runne fine, may come off, smooth and neate.

Lastly, the patterne of the Breech, with all the Mouldures, and Casca-  
 bell is in like manner to bee couered ouer by little and little with the same tempered earth, which must afterwards be luted neatly and strongly to the Breech end of the outter Colume: All which Mouldures, Rings, Armes, Deuices, Flowers, Trunnions, Dolphins and Circles may be at pleasure ad-  
 ded therevnto, vpon the patterne eyther in waxe, earth, or playster, and so the perfect impression thereof be receiued by the concauity of the outward Colume, keeping still the due prescribed proportion of the Peeces, according to the kind and sort thereof.

## CHAP. XXII.

*Of the place, measure, and vse of the Trunnions.*



He *Trunnions* in peecees not Camber bored ought to be thus placed, diuide the whole length of the Chafe of the peece into 7 equall parts, and at 3 of those parts from the *Base ring* forwards, in the imaginary right line that proceedeth from the lower part of the Mettall at the Breech, to the vpper part of the Mettall at her Mouth, must the place of the Centre of the *Trunnions* be, and so shall there be 3 of the length of her *Chafe* from the Centre of her *Trunnions* forwards to her Muzzle, & 3 backwards to her Breech, except it be for a Taper bored or Cambred peece, for which the  
 Trunnions

Trunnions must be placed more backwards, because the thicknes of mettall to the breechwards is greater in compared proportion then it is in equall bored Peeces, which would otherwise become breech heavy, & so be troublesome to manage, and it must be so ordered for these sequent reasons. First for her better fortitude, Namely to take hold the more firmly in the Mettall of her body, and not lye directly against the concaue Cillinder of the Bore. Secondly, that being somewhat vnder it, they will the better support the great waighr of the mettall: and lastly, that thereby they may be onely so much heavier towards their Breech as may be sufficient to keepe her steady in her discharge, and not be too vnweldy, but conueniently approaching neere equiballancing for the mounting and manning thereof, which the *Germane* and *Spanish* Founders doe somewhat seeme to helpe, by placing Dolphins somewhat more towards their breeches: and some others haue thought to remedy it by placing of strong Rings in Staples of cast mettall in stead and liew of these Dolphins. But for such Peeces as haue neither Dolphins nor Rings to mount or dismount by them, a Leauer being put into their Mouthes, and a rope fastned at the mouth vnto the outward end thereof, and vnto the Pomell or Cascabell at the breech, they are to be thereby equibalancingly slinged to mount or dismount them conueniently. The Trunnions ought next the body to be in Dyametre one Calibre of her proper bore in thicknes, and also one in length, onely lessening  $\frac{1}{10}$  of a Calibre, tapering by little and little towards their outward end of them. There are five things especially to be regarded in casting of mettall. The first is to make the formes and moulds duely. The second that they be well nealed with Charcoales or dry wood. The third to place them well in the Pit. The fourth is to melt the mettall to runne well and fine. The fift to be sure to put as much mettall into the furnace as may be sufficient to fill the moulds; and euery mould (that is to be filled with Brasse or any other Mettall) must haue spyalls or vents: for there is no place (although called empty) so voyd, but it is filled with Ayre, by meanes whereof if the hot meltes, substance come to meete with the Ayre there inclosed, not finding breathing vent, it will breake the the mould: wherefore it will be fit that as vpon the one side of the mould, the mettall is to come into it, vpon the other side the moysture and ayre may breath out without impeachment, that all the emptines of the mould may be filled with mettall. And to that end there must bee a vent made that may breath out the ayre from the top to the bottome of the mould, concluding that by giuing the more and the larger enteries vnto the moulds and vents, the better and more faire will your matter bee cast off. And so much for Foundings of Brasse Ordnance.

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CHAP



## CHAP. XXII.

*How to examine, search, and to finde whether any peece of Ordnance  
be well and duly made, and of what Kinde,  
and Sort it is.*



He principall thing that a Gunner ought to looke vnto, when hee is to take many Peeces of Ordnance into his charge, is first to search and examine how they are Fortified, and whether they be sound and safely seruiceable. and whether they be of the kinde of *Cannons of Battery, Culuerings, or Periors*, and then to know of which sort each Peece is of that Kinde; and then whether they be ordinary, re-inforced, or lessened in their Fortification of Mettall, and whether they be Cambred, either equall or Taper-bored, and with, or without an *Orlew* or *Relish*, be they of cast yron or of Brasse mettall: and of what heights their Bores are, and how much Powder they are each of them to shoote, with any Shot, be it of Lead, Iron, Stone, Granado, or other Fire-workes or Bales.

Secondly, that he looke how the *Spunges, Ladles, Rammers, and Waddbookes*, are fitted and conditioned, so that there may be no defect or default in them: And finding all those things well, hee is to place them all on the right side of the Cariages of the Peeces they belong vnto, so that the *Ladles* and *Spunges* be turned towards the mouthes, and the *Rammers* and *Waddbookes* towards the Breech of their proper Peeces.

Then by putting a *Rammer* with his staffe into the Peeces Concaue Cillinder as farre as it will goe, to know whether that Peece be cleare, loaded, or Cambered, and equall or taper-boarded, with Relish, or not, or haue any foulness got into her Concaue Cillinder, which hee shall perceiue if hee make a marke vpon the staffe, at the mouth of the Peece, and pulling it out when it will goe no further in, and by laying it vpon the out-side of the Mettall, if it reach to the *Touch-hole* or not, for if it doe not reach thither, it is either loaded or cambred, or else some foulness is gotten into her. And if he finde or perceiue nothing to be within, yet he shall take her *Ladle*, and put it into her as far as hee can, and mouing it lightly about the lower part and bottome of her concaue, giuing two or three ietts, to receiue into the same, the dust or small stones or foulness if any be in her, which he shall continue, drawing out the Ladle and emptying it, vntill hee perceiue there remaineth no more within her to be drawne out: Then placing the *Ladle* in his place, let him also take her *sponge*, and sponge her well; to draw out all the moysture, rust, Verdegreece, or foulness, vntill she be cleane: then search also her *Touch-hole*, with a *Prying-iron*, whether shee be therein cleane, cloyed, or haue any foulness gotten into it.

That done, then may he with a common search vpon a staffe, hauing two or threeround Pease, poynted springs that beare out, vntill they be forced close put into the concaue Cillinder vnto the bottome, all along to examine her within whether there be any flaws, crackes, hony-combes, pynne-holes, finders, or other faults: and the Sunne shining cleare, if the mouth  
be

be turned against the Sunne beames, they may by a Looking-glasse well polished, or with a bright sword, be reuerberated into her concaue Cillinder: so that those faults may bee therein most easily discerned; or else in close weather or roomes, a Wax or other Candle lighted, being fastned vpon the end of a Cane, staffe, or halfe Pyke, her faults may bee spied, if the same bee put into her hollow Cillinder, and carefully looked for all along, the *Gunners* eye being therefore imployed diligently at the mouth of the Peece.

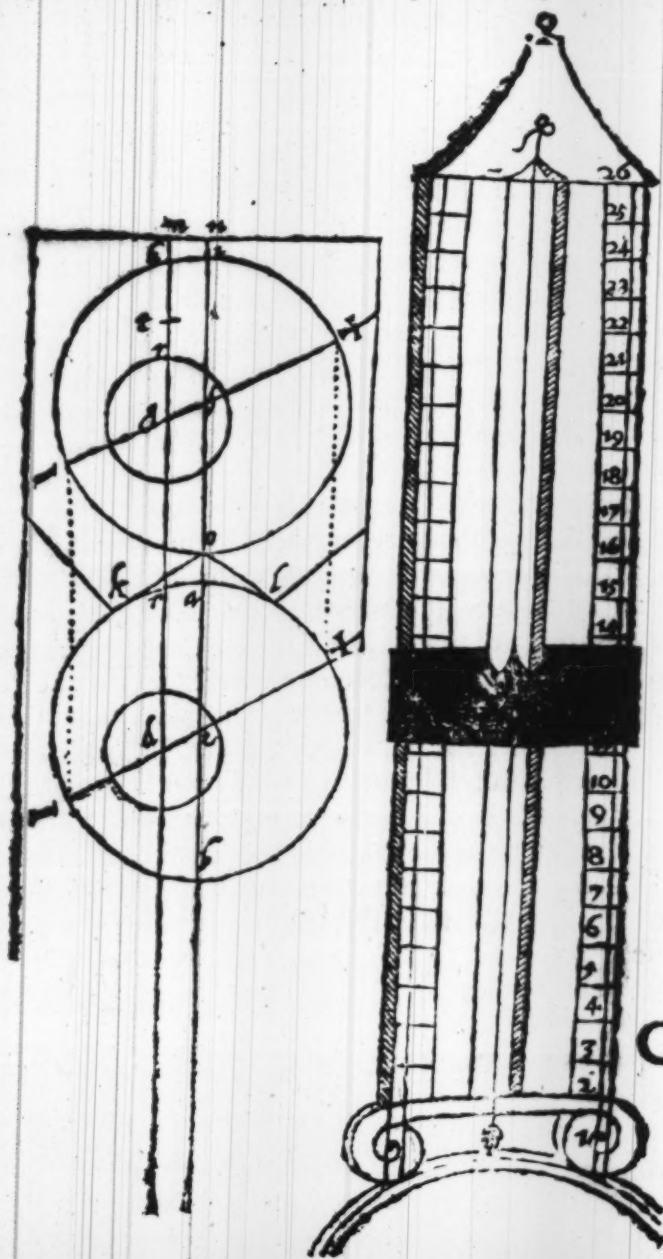
Wherein if he espye any creuises, flawes, cracks, or Hony-combes, hee may assure himselfe that Peece is dangerous both for breaking by recharging of her too speedily after her discharge, as well for her debility by meanes of those defects or faults, disabling her to endure or resist her ordinarie loading, or allowance of Powder to be fired in her, as also least in such Cauernes, flawes, or Hony-combes, some of the Wad, Carthouch, foulnes, furre, or Powder, lye smothering therein, and so vpon recharging, Fire, the Powder that should load her, vnlesse shee be well spunged with wet sponges, with a great deale of handinesse, care, and diligence, to bee assured to haue fully extinguished the fire that shall so smother, before you recharge her. Besides, much discretion and iudgement is to be vsed in the allowance of Powder, as in the manner of loading such Peeces, notwithstanding they be otherwise double fortified or re-inforced Peeces, yet to allow them (according as they are thereby more or lesse weakened) so much more or lesse Powder, as if they were of the lessened poore, or slender, fortified Peeces of the same kinde and sort.

It may many times happen that he may meete with Peeces that are wider at the mouth, then in the rest of her bore within, which is often found in Peeces that haue bene long, and many times vsed to shoote Shott of Iron or stone, whereby the mouthes become enlarged, worne, and wider, by reason of the frequencie and vehemencie of their discharges, whereby the Gunner may be deceiued, if he take his measure for his Shot by the Callibre of her mouthes, for by that meanes the Callibre of their bores within being lower or lesser, it may cause the Shott to sticke by the way, and then a vacuity being in her betweene the Powder and the Shott, they will endanger the Peece to breake, which may soone bee examined with the *Crossest*, described in the 19 Figure a, whereby Shott for such Peeces may be safely chosen seruiceable, according to the Callibres of their narrowest places, giuing abatement of  $\frac{1}{2}$  of that height (though the Shott be round, and not oually) for a conuenient vent, whereof more hereafter shall be spoken.

If he chance to meete with a Peece that is crooked in her *Chase*, which is a hard matter to be otherwise remedied, then by sending her to the Furnace to be new Founded: But if by necessity a *Gunner* must needes serue with such a Peece, then must he take a Shott for her so lowe, that he be sure not to be hindred in the going out thereof, in her discharge. And besides, he must accordingly (as the crookednesse lyeth) lay the Peece so much the contrarie way awry, ouer, or vnder the direction of the vpper part of the Mettrall more or lesse, as her bending and crookednesse is more or lesse; the which after two or three Shotts made in her, the *Gunner* shall bee better directed then by many words.

Lastly, he may many times meete with Peeces whose concaue Cillinder notwithstanding

notwithstanding it proceedeth from the breech to the mouth directly straight, yet it lyeth awry in the body of the Metall thicker or more towards one side then the other, which cometh eyther by the ignorance or negligence of the Gunne-founder. The Mould not being so iustly fitted, that the solide *Cylinder* thereof, filling vp part of the vacuity of the outmost Colume of the Mould, thereby to make the *Concave Cylinder* of the Bore, as to be scituated iustly in the midst or right line of the *Axis*; The which is so great a fault, that if it be not well and artificially handled and ordered, it will be impossible to make a good shot therewith, besides the dangers that depend vpon such Peeces: for being thinne of one side, although it be thick on the other, yet must it be allowed no greater charge of powder then if the same were as thin on the thickest side as it is on the thinnest, for if she have a charge of powder vsually allowed to good Peeces of that kind and sort, she will bee in great danger to split or breake: wherefore very great care and iudgement must bee to fit her Charge according to her ability, and also to frame and place her dispart duely, wherof also in his proper place hereafter, in the 26, 27, & 28 Chapters, shall be more particularly declared.





CHAP. XXIII.

How to measure or Tertiate any Peece of Ordnance, to know  
how much Powder she is able to beare for  
her due Charge.



He best vnderstanding experienced Forreigne Gunners, doe call the measuring and examining of the fortification of Mettall in a Peece, *Tertiating*, because it is chiefly to be measured and examined in the three principall parts of each Peece: namely, at the breech, at their Trunnions, and at the mouth.

Now that euery industrious Gunner may be assured of the fortitude of any Peece of Ordnance, and so the more safely and boldly allow vnto her a due loading, and proportion of powder, for prooue and service, that she may without danger performe her utmost execution, I haue in the 18 figure described three Cannons, and three Culuerings, with the measures of their mettalls (their proper Bores being their proper Scale) at their Breeches or Chambers, & at their Trunnions, and at their Mouthes. The vppermost of both which, is the figure of a Re-inforced or double fortified, the two middlemost of an Ordinary, and the two vndermost of a Lessened Peece, both Cannons, and Culuerings, with all their measures. By which also their sorts, and all other Ordnance in their due measures, will be the better conceined and manifested,

As for example there is a Culuering that shooteth an iron shot of 17 lb. waight with 13 lb. of corne powder, which is  $\frac{1}{3}$  of the waight of her shot; and the question is whether she may be able to beare so much powder, or if neede were more, which cannot be well answered without the examining or tertiating her mettall.

But hauing already searched her, as in the precedent Chapter is shewed, and found her sound and free, except the defects therein mentioned, you may measure and tertiate her to answer the question as followeth.

First, with a Ruler, draw a right line vpon a paper slate or flat smooth board, as in the said 18 figure is described from A to B, Then with a paire of Compasses with strait or reuerfed poynts, take the Dyametre or widenes of the Bore of the peece, and place that measure from A towards B at C, which space betweene A and C, you must diuide into two equall parts, and then with the compasses opened to one of those parts, set the same vpon another right line, as at the poynt D, and with the other foote draw a circle, which will be truly equall in Dyametre vnto the height of the Bore, as may appeare by the Circle A F C Q, and equall to the right line AC.

Then with a paire of Caliber Compasses take the thicknes or Dyametre of the mettall of the Breech at the Touch-hole: which distance betweene the poynts, you must diuide into two equall parts, and then the Compasses bee-

ing opened to one of them (and one foote set in D with the other) describe the other Circle GH, which shall be equall to the circumference of the metall at the *Touch-hole*, and so the thicknes of the metall or distance between the said 2 circles will shew the quantity betweene F and H, and E and G.

And seeing that the distance from F to H is equall to the distance from E to F, which is the Dyametre of the height of the Bore, he may be therefore sure that it is an Ordinary or Common fortified *Culvering*. But whether it bee either a Bastard or an extraordinary *Culvering*, it cannot bee knowne by the fortification, but by the length therof; being longer then the ordinary, it is called, therefore an extraordinary *Culvering*, &c. and being shorter then the Ordinary, it is therefore called a Bastard *Culvering*.

Now then this being found to be an ordinary *Culvering*, there will beare  $\frac{1}{4}$  of the weight of her shot in Cannon powder, which amounteth vnto 13 lb. 9 oz. But to bee more assured of her fortitude, the measure of her metall may be likewise taken at her *Trunnions*, and *Necke* as followeth.

At the Cornish or Ring before her *Trunnions* with a paire of Calibre Compasses, you may take the Dyametre of the body of metall there, as you did before at the *Touch-hole*, and also diuide the distance betweene the points or ends of the compasses into two equall parts: with the compasses opened to one of those parts, setting one foote in D, make with the other the circle IL, and if you finde  $\frac{1}{4}$  of the bore, it is the proportionall fortification for an ordinary *Culvering*; and the like may bee done for the *Necke*, which the circle MN will equalize and represent, and the distance from F to N being  $\frac{1}{4}$  of the height of her bore, and the due thicknes of the metall for an ordinary *Culvering* at the *Necke*, confirmeth the former measures and proofes.

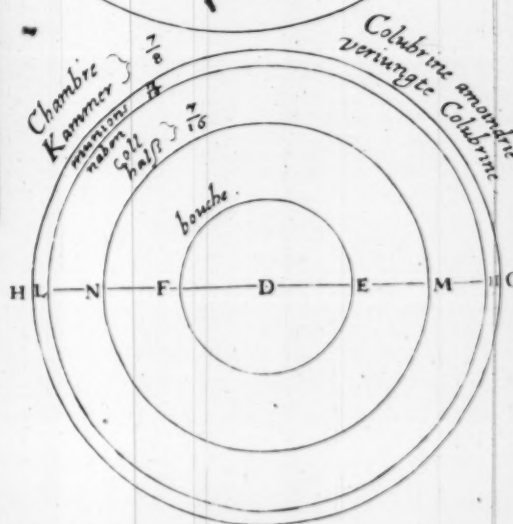
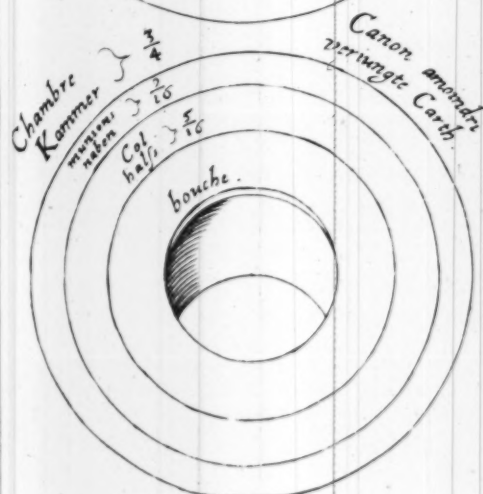
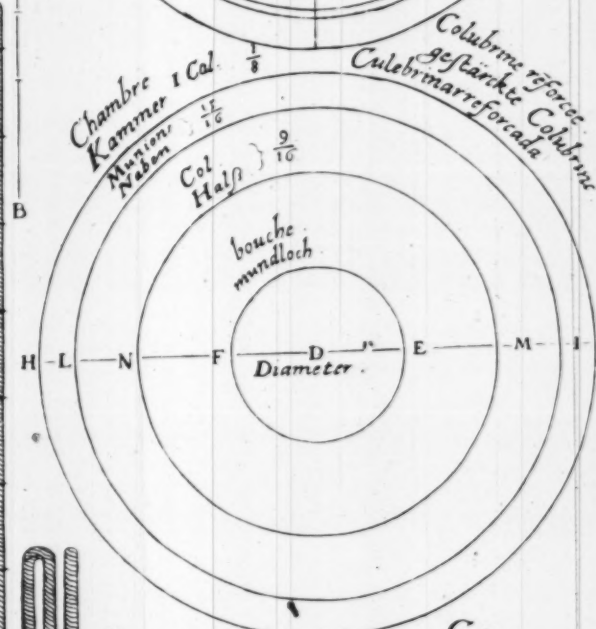
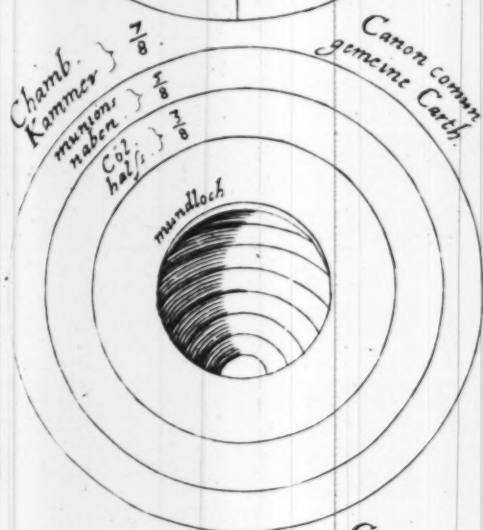
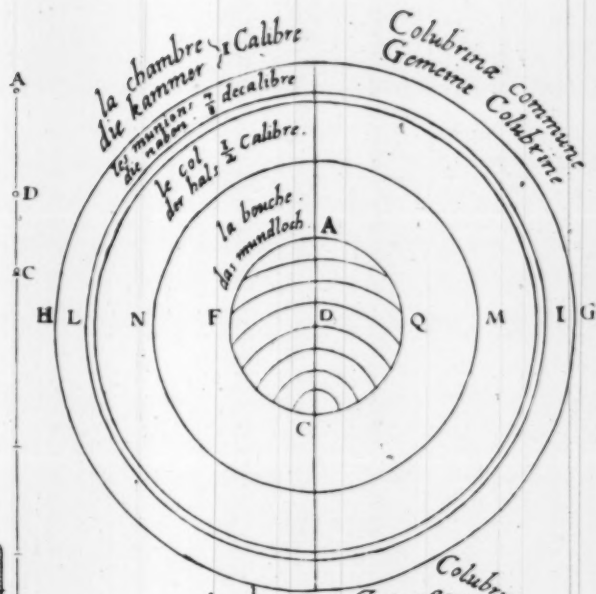
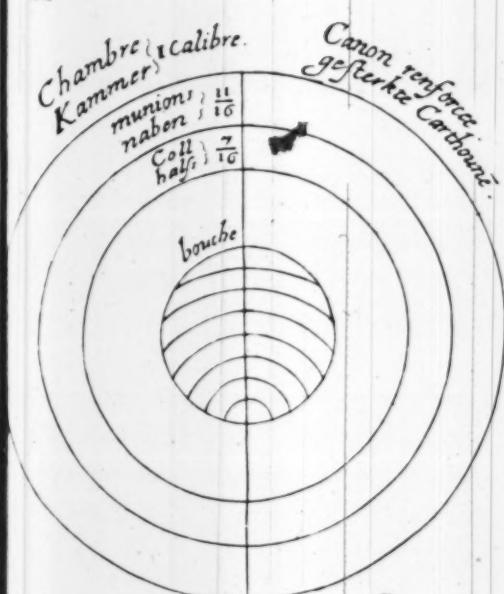
But if in taking the Measures aforesaid, there had bin found in her Chamber at the *Touch-hole* from F to H the thicknes of one Dyametre of the bore, and  $\frac{1}{4}$  more, it had beene a signe the Peece to be double fortified or re-inforced, hauing also at the *Trunnions* FL  $\frac{1}{4}$ , & at the *Necke* FN  $\frac{1}{4}$  of the height or Calibre of her Bore, Then she shooting an Iron shot of 17 lb. would haue endured also 17 lb. of Cannon corne powder to be loaded with, and be fired within her without danger. And this would so haue conueyed the shot further then the ordinary could haue done, vpon like degrees of Mounture.

Contrariwise, if the circles there had beene found, that from F to H, but  $\frac{3}{4}$  of her Calibre of the bore at the *Touch-hole*, and at the *Touch-hole* but  $\frac{1}{4}$  for FL, and at the necke from F to N but  $\frac{3}{4}$  of the height of her bore. Then she appeareth to be one of the lessened or slender fortified *Culverings*, and must be allowed but 12 lb. 9 oz. of Cannon corne to conuey her Iron shot of 17 lb, which vpon like eleuation will not cary a shot so far as the Ordinary, much lesse as the extraordinary *Culverings* could haue done.

In this selfe same manner all sorts of Peeces of the second kind are to bee measured and *Tertiated* with this consideration and allowance withall, That the *Demy Culvering* hath  $\frac{1}{2}$ , and the *Saker*  $\frac{1}{3}$ , and the *Faulcon*  $\frac{1}{4}$  more metall comparatiuely then the whole *Culvering* hath. And so much for the sorts of the second kind of Ordnance.

Likewise vpon the other side of the same figure, the Measures of the Ordnance are thus described.

The



Comment il faut mesurer les pieces d'artillerie.  
Wie das geschütz zu messen.





The double fortified or re-inforced *Canons* of Batterie, haue one whole Dyametre of their bore in thicknes of mettall at her *Touch-hole*, and  $\frac{1}{2}$  at her Trunnions, and  $\frac{1}{4}$  at her necke.

The ordinary *Canons* of Batterie is  $\frac{1}{2}$  in their Chambers,  $\frac{1}{2}$  at their Trunnions, and  $\frac{1}{4}$  at their Neckes of the Dyametre of the Bores in thicknesse of mettall.

The *Lessened Canons* of Batterie is  $\frac{1}{2}$  at the Chamber, at the Trunnions  $\frac{1}{2}$ , and at the necke  $\frac{1}{4}$  of the Dyametre of their Bores in thicknesse of mettall, whose poorenes and debility of mettall, although they be to shoote an Iron shot of about 60 lb. yet they cannot endure about 25 lb. of fine powder, or 31 lb. of common powder.

Whereas the *Re-inforced Canon* of Battery can endure to burne 34 lb. of fine powder or 43 lb. of common powder.

And so the *Ordinary Canon* of Batterie will endure 30 lb. of fine, or 39 lb. of common powder.

But if the *Gunner* when he should measure or tertiate any Peece, hath not Calibre compasses, he may doe it sufficiently with a cord or string by winding the Peece at the Touch-hole, at the Trunnions and at the Necke, taking  $\frac{1}{3}$  part thereof for the Dyametre of the body of her mettall in each places, Thus:

The *Canon* or ordinary *Culuerings* haue about 11 Dyametres of their bore about at the Touch-hole, and at the Trunnions 8 Dyametres, and at the necke 6 Dyametres in their circumferences.

But the *Common* or *Ordinary Canons* of batterie haue but 9 Dyametres at the Touchhole, and at their Trunnions 7 $\frac{1}{2}$ , and at their necks 5 $\frac{1}{2}$  in the circumference of their mettalls there.

Lastly, the *Demy Canons* are but  $\frac{1}{2}$  of their bores in thicknes of mettall at the Touch-hole: I need not to insist vpon the rest of the measures, nor of the Re-inforced Ordinary or Lessened, onely I may say that as they all tend to none other end, but to make knowne the force and feeblenes of any Peece, to allow her a conuenient charge of Powder, that they may performe their best and vtmost force most safely: for if you giue any Peece more then her due charge in powder, you indanger the Peece your selte, and the seruice expected, but if you giue lesse she cannot doe sufficient execution.

The force and richnes, and the defects and poorenesse of the Powder, is likewise to bee well knowne for 10 lb. of one powder may doe more execution then 12 lb. of another, wherefore encrease or abatement must bee accordingly made to or from the quantity, that is ordinarily allowed, according to the strength thereof, more or lesse, whereof I intend to speake more particularly in the chapter of the making and prouing of Powder.

But yet I will conclude with a brieft and industrious way to measure a Peece as is by the 19 figure & represented: First draw a right line, as the line CD, then take the wideness of the bore of the Peece with a paire of straight poynted compasses, and set both the poynts in the said right line from C towards D, as CF which will be the height or wideness of the bore of the Peece. Then with a paire of Calibre compasses take the Dyametre of the mettall at the breech, which being also set in the same right line from C towards

wards D as c E. Lastly, diuide E E into two equall parts at A, so will F A or E A be the thicknes of the mettall at the breech. The like may be done at the Trunnions or Mouth.

## CHAP. XXV.

To finde whether the Concaue Cillinder of any Peece of Ordnance bee in the midst of her mettall, if not where the thickest or thinnest of the Mettall is, and the difference thereof, and of the longest and shortest distances from the Axis of the mettall to the Axis of the bore, with their Lar- ges and Disparts.



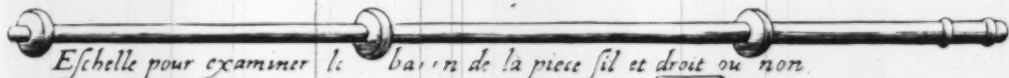
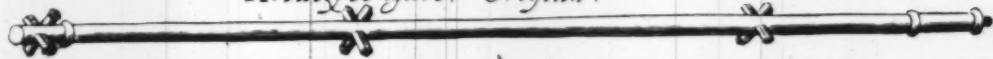
Efore I proceede any further, it will not be amisse here to shew the vse of *Paralell Squire* described in the 19 figure 4, which is an instrument requisite to finde & examine whether that any Peece hath more mettall vpon one side of her then on the other. The same is of two perches or peeces made square of good seasoned wood planed straight and smooth, ioyned at the end with two trauers peeces truely let in and well closed in their ioynts, so that as one of the pearches may come neerer or goe further off from the other as the Peece to be measured shall require alwayes, keeping the two pearches exactly paralell one to the other, and so locked with skrew pinnes and nuts, as that they may not boudge without his will that vseth them.

These pearches haue in each of them 5 or 6 skrewes with pins of brasse or Iron, that the one pearch being put into the Cillinder of the bore of a Peece of Ordnance, the pins and skrewes with their halfe round heads may so beare vpon the lower side of the bore, that it may hold vpon the pearch close to the vpper side thereof, all along euen to the Touch-hole. Then by the Trauerses, locking the Perch that is without, that the further end may touch & rest vpon the Basing, and the vpper pinnes also touch the Cornish frieze, and other eminent rings of the outside. Then turning the said instrument round about, all the concaue or soule within and about the mettall or body without side of the Peece, if you finde it to touch all parts equally in such reuolution, you may be assured the Peece is truely bored in the midst of the mettall; but if it touch not equally but bee stayde or stiffe vpon one side, and loose, that the pinnes beare or touch not one the other, it is certaine that the side where it is loose, is thinner in mettall, then the other where it goeth stiffe or stayeth.

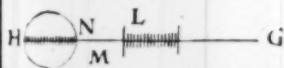
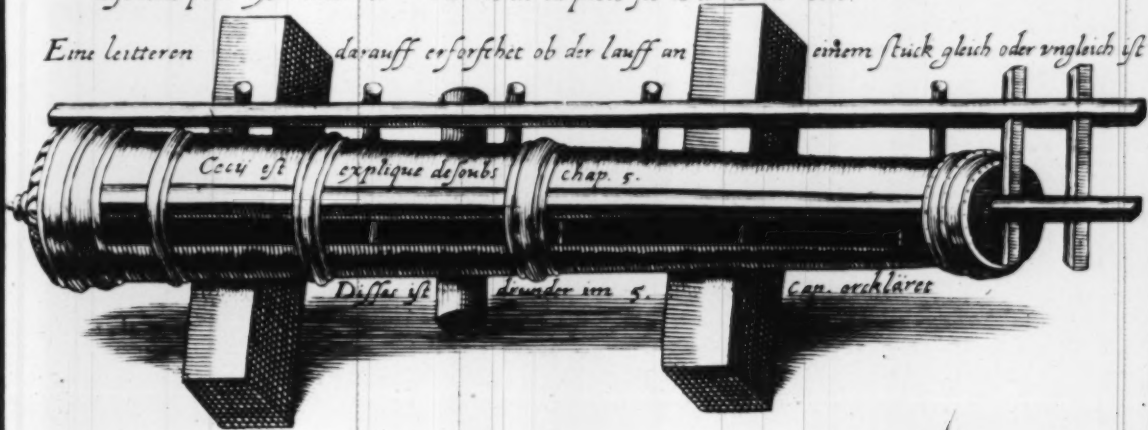
The places which is thinnest & thickest, being knowne by the stiffenesse or loosenesse of the pinnes in the turning, and the lengthning or shortning of those pinnes more or lesse, will also make knowne the quantity how much one side and place is thicker or thinner then another, and that throughout euery



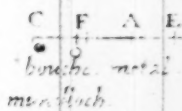
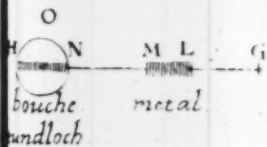
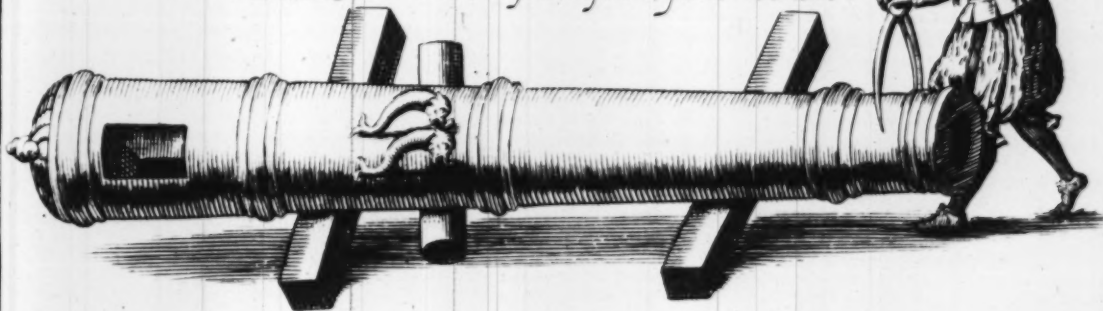
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Kreutzstenglein. Crosetta.



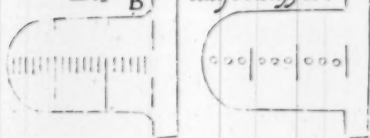
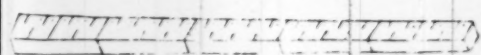
Eine leitteren darauff erforschet ob der lauff an einem stuck gleich oder ungleich ist.



Comment il fault mesurer vne piece.  
Wie ein stuck soll visirer werden.



la cueilliers de charge.  
Die B ladtschauffel.



Regla pour signer les lignes droitte.  
Zoll stab daran die streck linien zu ziehen.



every part of the Peece noting the thickest side with the Algebraicall figure of more thus  $\infty$  and the thinner with the character of lesse thus  $\ll$ , marking and noting very diligently how much the excesse is, and in either of those places with a cord, or rather a parchment that will not stretch, guird the Peece round about, Then halfe-ing that guirting, by doubling it, lay one end of it vpon the character — that is where the mettall is thickest, and where that halfe endeth there is the thinnest by the 15 definition of the first of *Euclid*: which being done both at the breech and mouth also, and how much the thickest or thinnest place is distant from the vppermost of the surface of the mettall in those places seuerally noted; so much is particularly prepared for the same Peece onely, yet how it may be applied in like sort for any other wrybored Peece, may by like practise be conceiued.

The same being done aswell for the Breech as for the Mouth, and transferred accordingly vpon a boord with Plumets in the centres of each circle, & one in the perpendicular Dyametre of the middle line of the boord, whose lower end must be somewhat hollowed, that it may bee the better applied vpon the roundnesse of the mettall of the breech and muzzle of the Peece, as the figure thereof may sufficiently explaine, it would bee too tedious, and not *opera pretium* further to describe the perpendicill, or to demonstrate the same, although I haue prepared for any friends that desire it.

Note for as much as it is very difficil to reclaime such Peeces from shooting awry, or ouer or vnder, without these curious preparations: And because they are not safely to be shot in, without very good and mature consideration of their weakenes and danger, for if an ordinary charge of powder be fyred in such a Peece, the weaker fortified part would not be able to resist the force thereof, but be in great danger to breake and split: therefore I would aduise every Gunner that shall be appoynted to serue with such a Peece, aswell for his safety as for his credite, cyther with or without reclaiming those Errors, not to load her with more powder then if shee were no better fortified in any place then she is in the weakest part, her surplussage at the thickest, being no better helpe to strengthen the thinnest of her mettall; then if she were in all places weake alike. Yet to examine the mettall of any Peece doe thus also, Mount the mouth of the Peece vpon a skidde or peece of Timber, and hauing from the vpper part of the mettall, made foure markes, or diuided the circumference of the Base and Muzzle Riggalls or Rings into 4 quadrants from the mouth to the Breech, hauing stretched a chalke line layd vpon two of those marks each with his match, striking with that line, 4 lines alongst vpon the outside of the body of the peece, and hauing a great care that they be truly lined; Then take a strait rod and put it into the mouth of the Peece, holding it close to the side of the concaue directly within it as the lines directeth, the one line whercof lying directly, his opposite will lye directly vnderneath it, and the other two lines will bee stretched on both the sides of the Peece.

Then take your Quadrant, and place one side thereof euen with the rod, and looke what degree the perpendicular plumlyne cutteth thereon, and so turning the peece, that one of the syde lines may then lye vpright, if the plumbyne then fall vpon the same degree at each line of such application



vpon them all, the Peece is then truly bored. Lastly, there may also for that purpose be an Iron or Brasse Instrument with a ioynt in the midst called Double Calibres with foure legges like the figure here described, which by putting them into the concaue of the Peece, and turning it round within the bore, clasping the other legge without to the mettall of the Peece, the distance betweene the other two legges without will shew the thickeesse of the Peece in each part, and shew, with applying all the openings vnto an inch Rule or scale of equall parts, whether the Peece bee thicker vpon one side then on another, being alike distant from the mouth of the Peece, and how much and where.



Which differences of thickeesse and thinneesse of her mettall, wry boring or vneuen lying, of the concaue Cillinder or Soule in her body or Mettall being so made knowne. The Large lyne and Large it selfe, together with her due dispart, and lying of the Axis, for such a Peece may be found as followeth.

## CHAP. XXII.

*To Dispart a Peece of Ordnance, whose Bore lyeth horizontally awry, and the Axis thereof being parallell to the Axis of the Mettall.*



Vppose that the Bore of the Peece lyeth awry so much of the Horizontall Dyametre square, as  $wv$ , or of the circumferences of the mettall at the mouth, as  $mn$ , or at the Breech as  $sr$ , here represented by the two parallell right lines, one  $vbm$ , being the verticall semidiameter of the middle of the mettall at the Breech, and  $vbm$  at the mouth. And  $wb$  and  $ns$  the other parallell, whereof  $wb$  is the verticall semidiameter of the middle of the bore both at Breech and Mouth, and  $bn$  the verticall thickenesse therein of the mettall of the mouth, and  $bs$  the verticall thicknes of the mettall at the greatest ring at the breech.

The difference of  $bm$  for  $bn$  being added vnto the difference of  $mr$  from  $sr$ , augmented by the lyne of the vsuall dispart  $rm$  (the difference at the vpper part of the mettall at the Breech and Mouth) will compound and make the due dispart little or nothing differing from the vsuall dispart, but must be placed

placed vpon  $\bullet$  perpendicularly paralell to  $mr$ , which shall direct the sayde Peece to make an assured good shot, the visuall line passing from the Gunners eye by  $t$  and  $\bullet$  vnto the marke to be shot at, by the 10 definition, and the 65 Theoreme.

But if the Bore or Soule of the Peece lye awrye, the Axis thereof not being paralell with the Axis of the Mettall.

As if the Bore at the Touch-hole were as the circle  $xbyd$ . and the Bore at the mouth, as  $egbf$ , and the Axis of the Bore passeth from  $v$  at the breech vnto  $\bullet$  at the mouth horizonrally leuell with the Axis of the mettall; Then shall the Dispart be of such length, as in the former ordinary manner, but the dispart lync vpon the mettall at the breech will passe directly from poynt  $x$ , vnto the poynt  $\bullet$  at the mouth of the peece, to make a perfect shot with such a peece at any marke assigned.

## CHAP. XXVII.

To Dispart a Peece of Ordnance, whose Centre of the Bore lyeth perpendicularly awry, eyther aboue or vnder the Centre of the midst of the mettall, and yet the Bores Axis being paralell with the Axis of the Mettall.

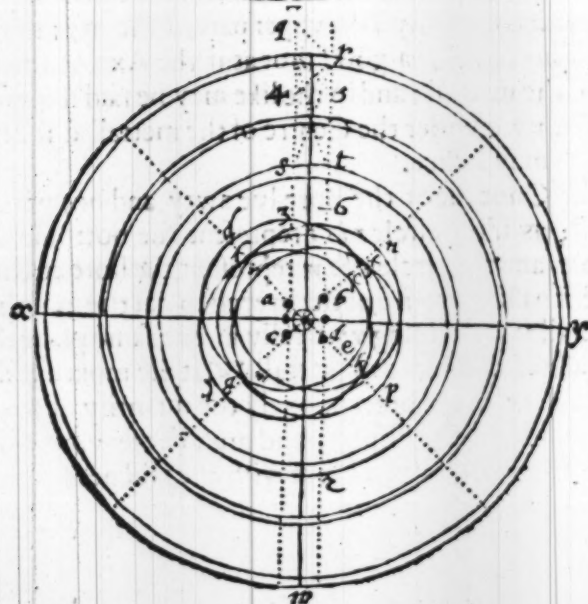
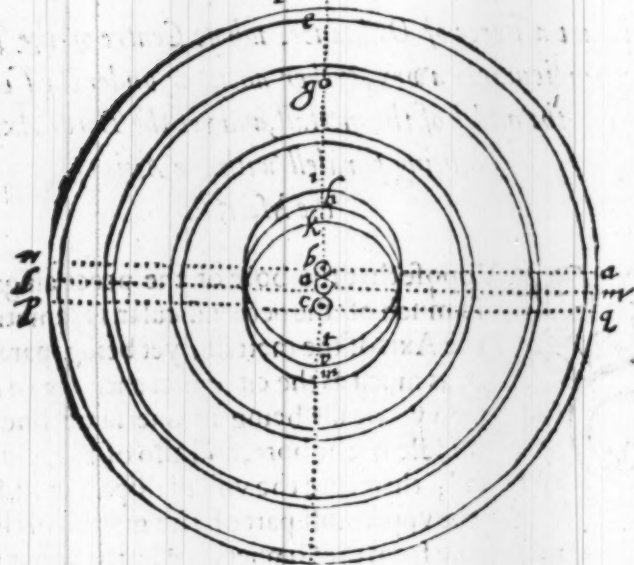
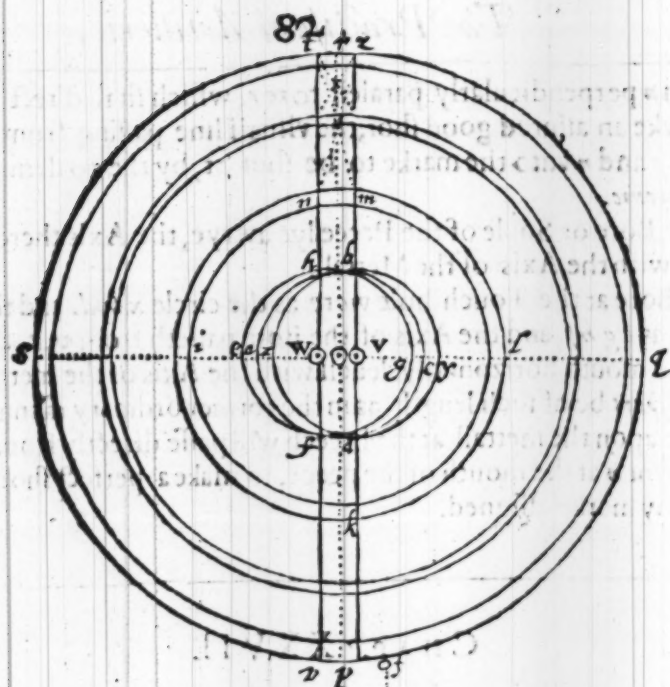


Vpposethat the bore of the peece assigned lyeth awry so much of the perpendicular Dyametre, as  $ab$  aboue the Axis of the mettall, yet being paralell thereunto, or as much as the circumference  $mo$  or  $bn$ . Herein the two verticalls being in one same line, both of the middle of the bore, and also of the middle of the mettall; therefore the visuall dispart must be placed vpon the vppermost part of the mettall of the mouth, and the visuall line must passe from the Gunners eye by the vpper part of the mettall at the Breech, and by  $d$  the vpper part of the mettall at the mouth, and will there serue to make a good shot as if the Axis of the Bore had lyen in the Axis of the mettall; and so the like may be said if it were in the perpendicular Dyametre, vnder the Centre of the mettall at the breech and mouth, as  $ac$ , which may suffice.

But if the Concaue of the Bore lye awry, and not paralell to the Axis of the mettall; as if the circle  $xist$  represent the bottome of the bore at the Touch-hole, and the circle  $rks\bullet$  represent the bore at the mouth, and the Axis thereof passing from  $b$  at the breech to  $c$  at the mouth, crossing the Axis of the mettall at  $a$  and lying vertically in one same plane therewith.

Then shall the difference of mettall  $Xd$ . at the mouth differ from the thickness of mettall  $ie$ . at the breech, onely the quantity of  $ge$ , which is the true height or length of the dispart, and must be set vpon the verticall point  $d$  at the mouth to make a good shot with the said peece at any marke assigned

to





to be shot at within the distance. For take  $kd$  out of the mettalls at the mouth of  $ie$ , the mettalls are at the breech, and will rest  $ge$  the Dispart sought.

But if the Circle  $rks$  be the Bore at the breech, and  $risv$  the bore at the mouth.

Then shall the thicknes of the mettall at the Mouth  $id$  differ the thicknes of the mettall at the breech  $ke$  the full quantity of  $df$  the true dispart for the same Peece to be set vpon the verticall point  $d$ . As  $df$ , to make a good shot at a marke assigned. For take  $id$ , the mettall at the mouth out of  $ke$  the thicknes of mettall at the breech, and there will rest  $ie$  equall to  $df$ , for the dispart sought, by the 10 Definition, and the 8 Demand.

CHAP. XXVIII.

To Dispart any Peece of Ordnance, whose Axis of the Bore lyeth awry not leuelly nor vertically, the Axis of the Mettall not being paralell thereunto.



Suppose first that the bore at the breech bee represented by the excentricke circle  $dgef$ , and at the mouth by the excentricke circle  $ofpg$ , and the Axis of the bore the right line  $ad$ . The outmost circle of the mettall at the breech by the concentricke Circle  $qrxw$ , and the outmost circle of the mettall at the mouth by the concentricke circle  $stx$ : So shall the thicknesse of the mettall at the breech be  $3q$ , and the thicknes of the mettall at the mouth be  $2t$ , which space or quantity  $2t$  being taken out of  $3q$  leaueth  $4q$  the dispart required, to be set vertically vpon the mouth at the poynt  $t$ , because the same is the point in the outmost mettall of the mouth that is vertically ouer  $d$ , the Centre of the bore at the mouth, and the large line shall be  $qt$ : for that  $q$  is right and vertically ouer the Centre of the bore vpon the outmost mettall at the breech, and  $qs$  will be the dispart line and part of the sight line that must passe from the Gunners eye by the poynt  $q$  on the Mettall at the breech, and by the point  $s$  the top of the dispart, set vpon the points  $t$  at the mouth, and so extending it selfe vnto the Centre of the marke assigned to be shot at; The like may bee said if  $b$  were the Centre of the bore at the Touch-hole, and  $e$  the Centre of the bore at the mouth: For then would  $rs$  be the large line, and  $r4$  the dispart line, and  $4s$  the dispart, each reciprocally answering the forenamed measures, being only placed alike on the contrary side which may suffice.

But if  $d$  were the Centre of the bore at the Touch-hole, and  $e$  were the Centre of the bore at the mouth.

Then would  $3s$  be the thicknes of the mettall at the mouth, which being taken out of  $2r$  the thicknes of the mettall at the breech, there will rest  $6r$

N

to

to be set vertically vpon the vpmost mettall of the mouth at *s*, because *s* is the verticall point there ouer *d* the Centre of the bore at the mouth of the Peece, so shall 6 *r* or 8, 7 equall thereunto be the length or heigh of the dispart, and *r s* shall be the large line, vpon the mettall passing from the breech to the mouth; and *r 7* shall bee the dispart line, part of the sight-line that passeth from the Gunners eye by the points *r* and 7, and extendeth vnto the Centre of the marke assigned, by the 10 definition and the said 8 Demand.

## CHAP. XXIX.

*Of the Larges, and the Large Line in wry bored Peeces.*



Having already shewed how to finde whether the Peece assigned were equally bored in the midst of the mettall, if not where the thickest and thinnest of the mettall lyeth, it resteth now to shew also how to find her middle line, or highest of her mettall at the breech and muzzle, as also her large and large line in a peece that is bored or cast awry.

The Middle line is none other thing, but an imaginary *Right line* supposed to passe vpon the highest of the mettall of a Peece of Ordnance from her Base ring to her Muzzle ring, directly and vertically ouer the Axis of the body of mettall of that Peece, which by the perpendicill aforesaid is easily found by placing the two corners *K* and *L* severly vpon the Base and Muzzle rings in such sort as that the plummet belonging to the line *n, o*, may hang directly ouer the same line, and being let downe, vntill the poynt thereof doe touch vpon the surface of the mettall there, make poynts or pricks at each place, I say then that those points will be directly ouer the Axis of the Mettall of that Peece, betweene which points if a Chalke line be stretched and stricken, or a right line imagined to passe, the same shall be the *middle line* of that Peece.

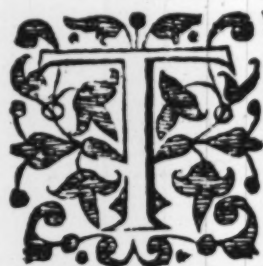
Now to finde the *Large lyne*, and the Large it selfe, in such Peeces as are bored, or cast a wry: Having found the midle Line, and the Plummet hanging so directly ouer *n. o.* vpon the said markes; and hauing found the Excentricke circles of the thickest, and thinnest of the Mettall, at the Breech, and Mouth, and described them vpon the Perpendicill, as is afore shewed, with their Perpendicular lines paralell to *n. o.* letting downe their Plumets, each in his proper place severally, so that it hang directly ouer his owne Perpendicular line, and that the point of the Plumet also touch the Superficies of the Mettall, and there at eath touch, make a marke and stretch a chalke-line betweene them, from the Base to the Muzzle rings, and strike a line vpon the Mettall therewith, or else imagine a right line to passe betweene them; I say, that line will bee Vertically ouer the Axis of the Bore, of that Peece; and is the Large line sought, and the distance betweene the extremes of the midle line formerly found, and this *Large line* vpon the Base and

and muzzle rings noted, are the Large it selfe: and so is that Peece reclaimed and prepared to auoid wide shooting.

Now it resteth also to reforme her ouer, or vnder shooting, whose cause may by the former sections bee conteinied, and by the perpendicill easily, and readily found and performed thus: First, vpon the marke vnder o, where the plumer touched, place a due Dispart for her, as if she were truely bored; then if the Centre of her Bore, at her breech bee found by the instrument, to be vnder the Centre of the Bore, at her Muzzle; the difference thereof, is then to bee subtracted, from the leuell height of the Dispart: But if the Centre of the Bore at the breech, bee higher then the same at the mouth, then that difference must be added, and placed vpon the marke of the Large, at the muzzle, with that addition, or abatement; and so the visuall line, must passe from the Large, at the breech, by the top of that Dispart there placed, which will auoyd all ouer, or vnder shooting in that Peece.

### CHAP. XXX.

To finde the waight of any Shot by the Diametre thereof, as well Arithmetically, and Geometrically, as Tabularly, and by Scale, and Compas.



The weight of the Shot, being a fit Index for the Gunner, to allow any Peece of Ordnance her due charge of powder; is therefore most necessary to bee made knowne, or first sought; and because a Gunner, cannot at all times when the weight of a Shot is required, haue Ballance and weights about him, to waigh the same; therefore, it shall not bee a misse, here to set downe, how hee may know the same, to a sufficient neerenesse, by the height of the Dimetre, or circuit of the circomference thereof; And that also for varietie sake, as well Arithmetically, and Geometrically, as Tabularly, and by Scale, and Compas.

The first thing to be done in Arithmetical working, is to finde the solide square inches, contained in the Ball, or Shot assigned; which may bee thus found, multiply the measure of the knowne inches of the height, or Diameter thereof Cubickly, and then againe multiply that Cube by 11, and diuide the last product by 21, and the number in the Quotient, will expresse how many solid square inches of Mettall, or Stone is contained in the Globall body of that Shot: If then you know, how much one square inch of the Mettall, or Stone assigned weigheth, you may then soone know the whole Shots weight sought, (for cast Iron 4 ounces allowed for each inch square, commeth neere the matter) and the proportion of Iron to Lead may be as 30 to 46: And ordinary Stone to Lead, as 18 to 72, and Stone to Iron, as 18 to 48, rollerable accepted.

But to come more precisely neere the truth (although spunginesse) and the



difference of each Mine from other, and infinite accidents, vary the proportions betweene their capacities, and weights, and doe hinder it. The table following will sufficiently helpe, in the meane space, I will giue one example to illustrate the precedent rule. As for example, it is required to finde thereby the solid square inches, in a Shot of 4 inches and  $\frac{1}{2}$  in height, the neere Cube of  $4\frac{1}{2}$  being neere 91, which I multiply by 11, & the product I finde to be 1001, which I diuiding by 21, finde in the Quotient 47 inches, and  $\frac{1}{2}$  of an inch more, for the solid content of that Shot, which if it were of Iron, by such allowance as aforesaid, it would weigh 11 lb. & about 15 ounces, but by the first Table following, it would be 12 lb. and 12 ounces, and by the sequent treble Table for Lead, Iron, and Stone Shots, it is found to bee but 12 lb. and 10 ounces, wherein appeareth also that a Leaden Shot, would bee 17 lb. and 15 ounces, which by the first Table, would bee found 19 lb. and 12 ounces. But for easinesse, some (and because it may for any Iron Shot be wrought by memory, by a man of any small practise) doe vse onely to divide the Cube of the Shot by 8, and take the Quotient for poundes, and each vnitie of the remainder for 2 ounces, and so the Cube of  $4\frac{1}{2}$  being 91, as aforesaid, and diuided by 8, the Quotient will bee 11 lb. and the 3 remaining will bee 6 ounces: The like in all kindes may bee done for Stone Shot, by the rule of 3 onely, saying, if 48 the proportion of Iron, giue 202 ounces, what shall 18 the proportion for stone giue? 76 ounces, which will bee 4 lb. and 12 ounces for the weight of the Stone Shot, that is 4 inches and  $\frac{1}{2}$  in height.

But the most artificiall, and exact Arithmetically working of all such questions, for all vsuall Mettalls and Stones, is according to the next Table, wherein, I haue imitated the Lord *Marchistones* Table, in his *Rabdologia*, applying this vnto ounces, and inches, which are our vsuall knowne weights and measures: Whereas his was for Cochleas, or Spoonfulls, and Drames, more vsed by Physitians, then knowne in Gunners practises, yet, for his two first Theoremes, and Problemes, I haue followed them, because their workes are easie, and excellent.

### *The first Probleme.*

By the inches of the capacitie, of the Mettall, or Stone named, to finde the ounces of the weight thereof.

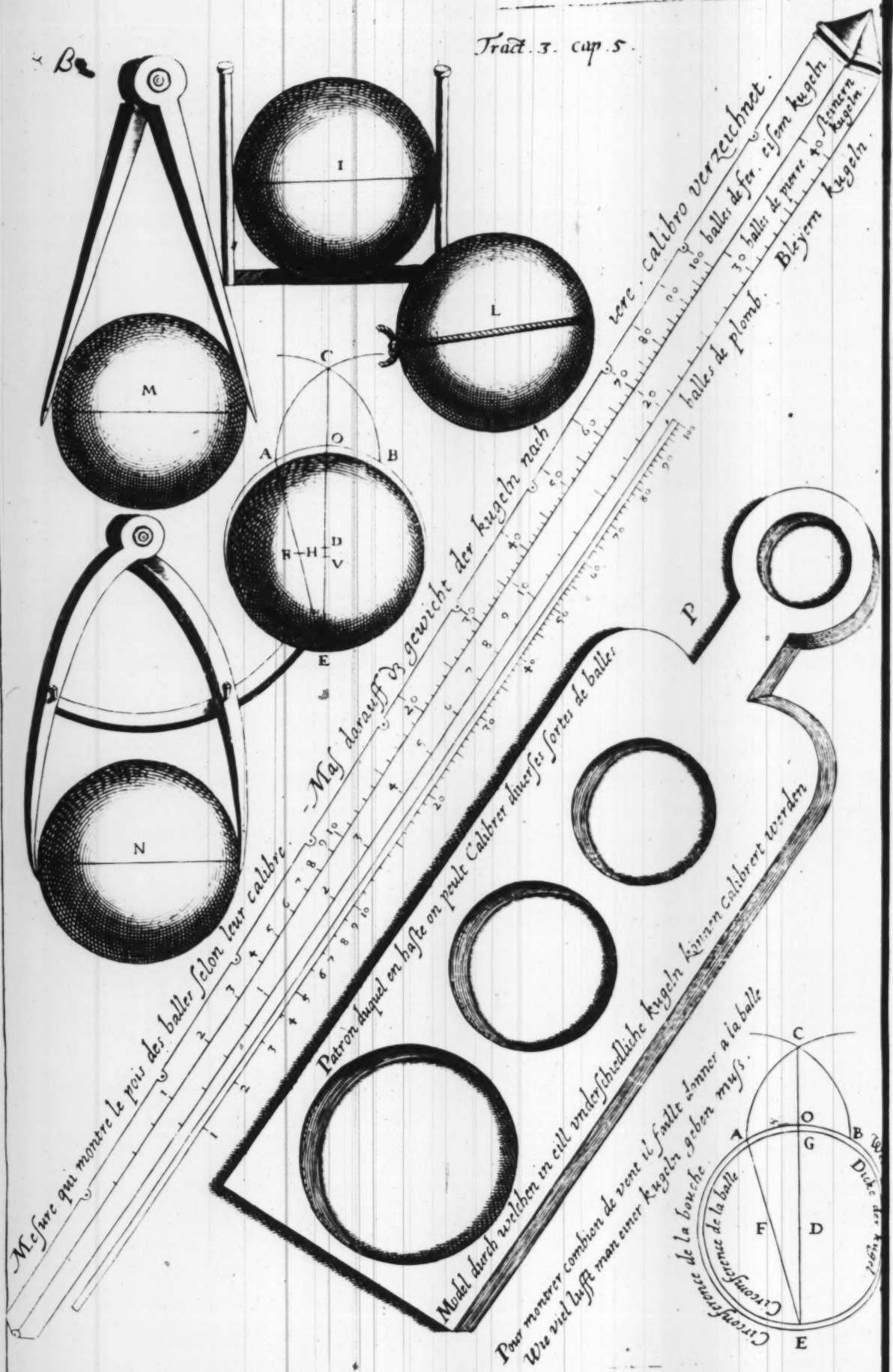
### *The first Theoreme.*

As a 1000 to the inches of the capacitie, or solid measure of the Mettall, or Stone named; So is the lowest number of the Colume, of the same Mettall, or Stone, to the ounces of the weight thereof.

### *The first Example.*

Let there be an Iron Shot of 8 inches high, which by solid measuring, (as aboue is taught) is found to containe 268 inches, and  $\frac{1}{2}$ : By the said first Theoreme, as 1000, to 268 $\frac{1}{2}$ , so is 4333 the lowest number of the Colume of







of Iron, vnto 1162 ounces which being diuided by 16 (the ounces of the Haberdepoise,) amounteth vnto 72 lb, and 10 ounces the weight sought.

*The second Example.*

Let an ordinary Stone shot, of the same height and measure be propounded, containing as aforesaid, 268 inches  $\frac{1}{4}$ , say, by the same first Theoreme, as 1000 is to 268  $\frac{1}{4}$ , so will 1420 the lowest number of the Colume, of ordinary stone thereof, bee to 382 ounces, which the Stone shot weyeth; they being reduced into pounds by deuision thereof by 16, will amount to 23 lb. 14 ounces, the weight of Stone shot sought.

*The second Probleme.*

By the ounces of the weight of any Mettall, or Stone named, to finde what number of solid inches it is in capacitie.

*The second Theoreme.*

As 1000 to the ounces of weight of any Mettall, or Stone named, so is the most right hand number of the Line, of the same Mettall, or Stone, to solid inches of the capacitie thereof.

*The first Example.*

Let there be a Shot of Iron of 8 inches Dyametre, weying 1162 ounces, and wee desire to know, how many solid inches it containeth: By the second Theoreme, as 1000 to 1162, so is 230 the most right hand number, in the Line of Iron to 268, fere the solid inches contained therein.

*The second Example.*

Let there bee a Shot of ordinary Stone, whose weight by the second example of the first Theoreme, will be 23 lb. and 14 ounces, whereof the solid inches is required: By the second Theoreme, as 1000 is to 382 ounces the weight, so is 710 the most right hand number, of the line of ordinary Stone, to 270 fere the solid inches required; exactnesse by Table, is not to bee expected.

N 3

A

*A Table for the Weights, and Measures, of  
Mettalls, and Stones.*

|              |                  |              |                |                |              |               |                |                  |      |
|--------------|------------------|--------------|----------------|----------------|--------------|---------------|----------------|------------------|------|
| <i>Gold.</i> |                  |              |                |                |              |               |                |                  |      |
| 1000         | 810              | 670          | 645            | 380            | 420          | 410           | 170            | 130              | 120  |
|              | <i>Quickfil.</i> |              |                |                |              |               |                |                  |      |
| 1392         | 1000             | 950          | 820            | 678            | 568          | 550           | 210            | 150              | 140  |
|              |                  | <i>Lead.</i> |                |                |              |               |                |                  |      |
| 1650         | 1150             | 1000         | 910            | 740            | 675          | 635           | 250            | 160              | 160  |
|              |                  |              | <i>Silver.</i> |                |              |               |                |                  |      |
| 1785         | 1340             | 1248         | 1000           | 820            | 710          | 750           | 270            | 200              | 180  |
|              |                  |              |                | <i>Brasse.</i> |              |               |                |                  |      |
| 2225         | 1680             | 1448         | 1345           | 1000           | 925          | 850           | 320            | 240              | 200  |
|              |                  |              |                |                | <i>Iron.</i> |               |                |                  |      |
| 2588         | 1930             | 1670         | 1535           | 1190           | 1000         | 930           | 380            | 260              | 230  |
|              |                  |              |                |                |              | <i>Tinne.</i> |                |                  |      |
| 2725         | 2045             | 1765         | 1640           | 1280           | 1160         | 1000          | 420            | 280              | 250  |
|              |                  |              |                |                |              |               | <i>Marble.</i> |                  |      |
| 6780         | 5120             | 4278         | 4090           | 2216           | 2784         | 2642          | 1000           | 710              | 680  |
|              |                  |              |                |                |              |               |                | <i>Ord. sto.</i> |      |
| 9960         | 7415             | 6405         | 5948           | 2650           | 4020         | 3828          | 1530           | 1000             | 710  |
| 13200        | 7880             | 6798         | 6315           | 4958           | 4333         | 4067          | 1645           | 1420             | 1000 |

CHAP. XXXI.

*The Geometricall finding the Dyametre, for the weight of  
any Shot assigned.*



Aviing a Shot of one pound, 2 lb. or 3 lb. weight of the Mettall, or stone assigned; if it bee of one pound, di-  
vide the Dyametre thereof into 4 equall parts, and 5  
such parts, will make a Dyametre for a Shot of the said  
Mettall, or Stone, that shall weigh iust two pound.

And diuide the Dyametre of a Shot, that weigheth  
iust 2 lb. into 7 equall parts, and 8 such parts, will make  
a Dyametre for a shot of 3 lb. weight.

And diuiding the Dyametre of a shot of 3 lb. weight, into 10 equall  
parts, and 11 such parts, will make shot of 4 lb. weight.

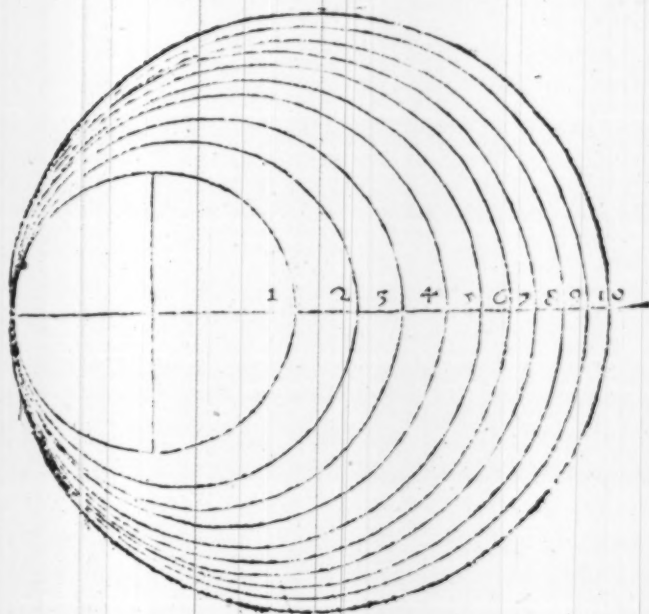
And diuide the Dyametre of a shot of 4 lb. into 13 parts, 14 such parts,  
will make a Dyametre for a shot of 5 lb. weight.

And diuiding the Dyametre of a shot of 5 lb. weight, into 16 equall parts,  
17 such parts, will make a Dyametre of a shot, that will weigh 6 lb: And  
so

so diuiding each next Dyametre into 3 parts equall more then the next lesser was diuided into, and it will with one part added frame a Dyametre of a shot, that will weigh iust one pound more; and so you may proceed infinitely, increasing, or decreasing, by taking one part lesse, then it is appointed to be diuided into, for 1 lb. lesse, and the next into 3 lb. lesse, to abate one from the remainder, infinitely decreasing it.

*A second Geometricall way.*

Having exactly the Dyametre of a shot that weigheth one pound; first describe a Circle, whose Dyametre shall bee iust equall thereunto, and diuide it into 4 Quadrants, with two Dyametres, cutting each other in the Centre Orthogonally, then take the Chord of the whole Quadrant, or of 90 Degrees, that is, extend your Compasses, from one extreame of a Dyametre, to the next, as in the figure following: Take the distance A. B, being supposed the Dyametre of a shot, or ball of iust one pound weight, which distance being set in the continued right line D. B. *f. g. h.*, and from E. to *f.*, then will D. *f.* bee the Dyametre of a shot of 2 lb, and then opening the Compasses from A. to *f.*, and setting the same from E. to *g.* Again, taking the distance from A. to *g.*, and setting it from E. to *h.*, so likewise taking the distance A. *h.* with the Compasses, and setting the same from E. to *i.*, and so continuing vntill you haue proceeded as farre as you will: You shall finde if D. B. were the Dyametre of 1 lb. that D. *f.* will be the Dyametre of 2 lb, and D. *g.* will be the Dyametre of a shot of 3 lb, and D. *h.* of 4 lb, D. *i.* 5 lb, D. *k.* of 6 lb, and D. *l.* of 7 lb, and D. *m.* of 8 lb, &c. and lastly, D. *q.* of 12 lb, whereby you may proceede in like manner infinitely.

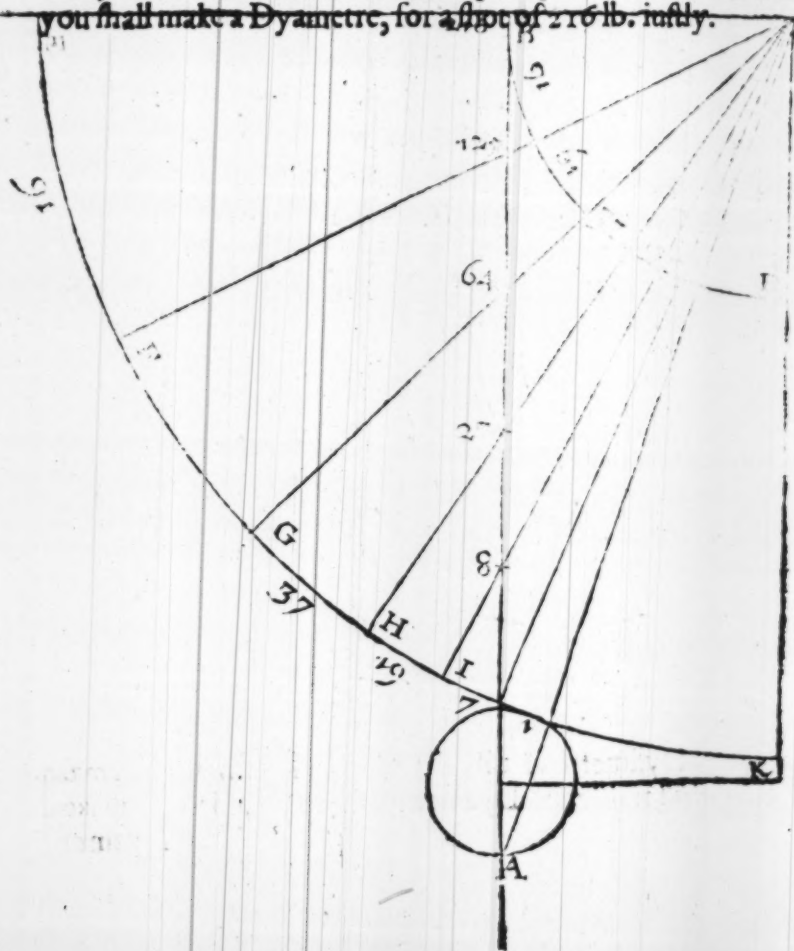


Or else you hauing a Dyametre of 1 lb, double that Dyametre will make a Dyametre of 8 lb, and treble the Dyametre of one pound, will make a Dyametre



Dyammetre of 27 lb. and the quadruple, or 4 times the same will make a Dyammetre of a shot of 64 lb, and 5 Dyammetres, will make a Dyammetre of a ball of 125 lb: and five times the Dyammetre of a shot of 1 lb, will make a Dyammetre of a shot, that will weigh 216 lb.

It reſteth now, to ſhew how to finde the meane diuiſions betweene thoſe extreames, as for the Dyametre of a ſhot of 2 lb, 3 lb, 4 lb, 5 lb, 6 lb, 7 lb, and more : ſo as by ſuch progreſſions, you may proceed from pound to pound, vntill you come to the laſt tearme, for extreame of 216 lb. Neuertheleſſe, the ſame manner of working will proceed infinitely; the former mentioned fixe Dyametres, being marked vpon one and the ſame right line, you muſt at the end of them, draw another right line Orthogonally, and ſet therein two ſuch Dyametres, as at C, and from thence draw another right line paralell to the firſt, from C. to K, then put one foote of your Compaſſes in C, and make a quarter of a Circle from B. to D, that done, plant a pinne, or needle in C, and then draw from the Center C. lines through all the diuiſion of the Dyametres, marked vpon the right line A.B, ſo ſhall you haue fixe diuiſions to be diuided: The firſt being diuided already, abideth as it was, and is the Dyametre of a ſhot, or ball of one pound; but the ſecond diuiſion, iſt to bee in the circumference, diuided into 7 parts equally; becauſe it containeth the ſecond Dyametre vnto 8, from 1 to 8, for adding 1 to 7, it maketh 8; the third diuiſion is into 19 equall parts, which being added to the 8, maketh 27; the fourth, ſhall bee diuided into 37 equall parts, which together with the 27, maketh 64; the fiſt ſpace ſhall bee diuided into 61 equall parts, which together with the 64, amount vnto 125; and laſtly, the ſixt ſpace muſt be diuided into 91 equall parts, vnto which adding the 125, you ſhall make a Dyametre, for a ſhot of 216 lb. iuſtly.



## Now

Now for as much, as these diuisions are deficill, to make well within so small a Quadrant, you may therefore describe a greater, as the Quadrant K. E, wherein the diuisions are more distinct, then in the lesser they can bee; further you may note, that Fire-balls, Granadoes, and other Globous Artifices, must haue the same proportion in their Grandures, from their Ball of one pound, which may bee exactly considered: and so by this method, you may make Balls of Lead, Brasse, Stone, Granadoes, Fire-balls, and all other Sphericall workes, of what weight you will, hauing one of one pound first to lead you, according to the precedent instructions.

A Table whereby, and by the Inch sight-rule, any Peece of Ordnance betweene sixe foot, and fiftene foot in length, may bee mounted to any Degree of the Quadrant, vnder twenty Grades as well as by the Quadrant it selfe, or by any other Instrument Whatsoeuer.

| Foot.     | Foot.   | Foot. | Foot.         | Foot. | Foot.         | Foot. | Foot.         | Foot. | Foot.         | Foot. | Foot.         | Foot. | Foot.         | Foot. | Foot.         |
|-----------|---|-------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|
| 6         | $\frac{1}{2}$   | 7     | $\frac{1}{2}$ | 8     | $\frac{1}{2}$ | 9     | $\frac{1}{2}$ | 10    | $\frac{1}{2}$ | 11    | $\frac{1}{2}$ | 12    | $\frac{1}{2}$ | 13    | $\frac{1}{2}$ |
| 14        | $\frac{1}{2}$   | 15    | $\frac{1}{2}$ |       |               |       |               |       |               |       |               |       |               |       |               |
| Gr. Inch. |   |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 1         | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 2         | 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20    |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 3         | 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20       |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 4         | 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20          |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 5         | 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20             |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 6         | 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20                |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 7         | 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20                   |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 8         | 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20                      |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 9         | 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20                         |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 10        | 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20                            |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 11        | 11, 12, 13, 14, 15, 16, 17, 18, 19, 20                                |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 12        | 12, 13, 14, 15, 16, 17, 18, 19, 20                                    |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 13        | 13, 14, 15, 16, 17, 18, 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 14        | 14, 15, 16, 17, 18, 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 15        | 15, 16, 17, 18, 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 16        | 16, 17, 18, 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 17        | 17, 18, 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 18        | 18, 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 19        | 19, 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |
| 20        | 20  |       |               |       |               |       |               |       |               |       |               |       |               |       |               |

A Table, shewing the Height and Weight of Iron, Lead, and Stone-shot, accurately and newly calculated by the Author, and applyed to our asize of English Measure of Inches and Parts, and to the Haberdupoize Weight of 16 Ounces to the Pound: With the Description of my Gunners Scale.

| Ynches<br>high | Quarters. | Iron pound<br>Ounces. | Lead pound<br>Ounces. | Stone pound<br>Ounces. |
|----------------|-----------|-----------------------|-----------------------|------------------------|
| 1              | 0         | 0                     | 3                     | 0                      |
| 1              | 1         | 0                     | 6                     | 0                      |
| 1              | 2         | 0                     | 9                     | 0                      |
| 1              | 3         | 0                     | 12                    | 0                      |
| 2              | 0         | 1                     | 11                    | 0                      |
| 2              | 1         | 1                     | 2                     | 0                      |
| 2              | 2         | 2                     | 3                     | 0                      |
| 2              | 3         | 2                     | 4                     | 0                      |
| 3              | 0         | 3                     | 5                     | 0                      |
| 3              | 1         | 4                     | 6                     | 0                      |
| 3              | 2         | 6                     | 8                     | 0                      |
| 3              | 3         | 7                     | 9                     | 0                      |
| 4              | 0         | 8                     | 11                    | 0                      |
| 4              | 1         | 10                    | 15                    | 0                      |
| 4              | 2         | 12                    | 17                    | 0                      |
| 4              | 3         | 14                    | 21                    | 0                      |
| 5              | 0         | 17                    | 24                    | 0                      |
| 5              | 1         | 20                    | 30                    | 0                      |
| 5              | 2         | 23                    | 35                    | 0                      |
| 5              | 3         | 26                    | 39                    | 0                      |
| 6              | 0         | 30                    | 45                    | 0                      |
| 6              | 1         | 34                    | 51                    | 0                      |
| 6              | 2         | 38                    | 57                    | 0                      |
| 6              | 3         | 42                    | 63                    | 0                      |
| 7              | 0         | 48                    | 72                    | 0                      |
| 7              | 1         | 53                    | 79                    | 0                      |
| 7              | 2         | 58                    | 87                    | 0                      |
| 7              | 3         | 64                    | 96                    | 0                      |
| 8              | 0         | 72                    | 106                   | 0                      |
| 8              | 1         | 78                    | 117                   | 0                      |
| 8              | 2         | 87                    | 130                   | 0                      |
| 8              | 3         | 95                    | 141                   | 0                      |
| 9              | 0         | 101                   | 150                   | 0                      |
| 9              | 1         | 109                   | 161                   | 0                      |
| 9              | 2         | 121                   | 181                   | 0                      |
| 9              | 3         | 132                   | 198                   | 0                      |
| 10             | 0         | 138                   | 217                   | 0                      |
| 10             | 1         | 164                   | 246                   | 0                      |
| 11             | 0         | 184                   | 275                   | 0                      |
| 11             | 1         | 216                   | 324                   | 0                      |
| 12             | 0         | 240                   | 360                   | 0                      |
| 13             | 0         | 305                   | 457                   | 0                      |
| 14             | 0         | 389                   | 583                   | 0                      |

**T**HE Use of this Table in the left margin, is to find out the height of your Shot in the two first Collume of inches, and quarters of inches: Then it is be an Iron shot, ouer against the height so found in the two second Collumes vnder the tytles of *Iron pounds* and *Ounces*, you shall finde the waight thereof. The like may be vnderstood, if the shot be of *Leade*, by the two third Collumes, or of *Sone*, by the two last collumes, each vnder his proper title, and ouer against the height assigned. As for example; For, an Iron shot of 8 inches, the weight will appeare to be 72. pound 10 ounces; and if it were of *Lead*, it would be found 106 pound 8 ounces; but if of *Stone*, then would it be but 26 pound 12 ounces, which may suffice.

The Description of my Gunners Scale, is to be made in Brasse by M. Allen: And in Wood, by M. Nathaniell Gors of Ratcliffe.

**I**T is a square Rule of one foote in length, made eyther of Brasse, Boxe, or other fine grayned Wodde that will not warpe: Vpon one side or square whereof I haue set the height of all sorts of Iron shot, from 1 pound to 100 pound weight: And of Stone shot to 37 pound: And of Lead shot to 150 pound weight: Each distinguished from an other by the Letter *I.* for Iron, *S.* for Sone, and *L.* for Lead-shot, and their Weights and Measures accomodated vnto our English Haberdupoiz weight of 16 ounces to the pound, and to our Foote of assize of 12 Inches to the Foote. The second

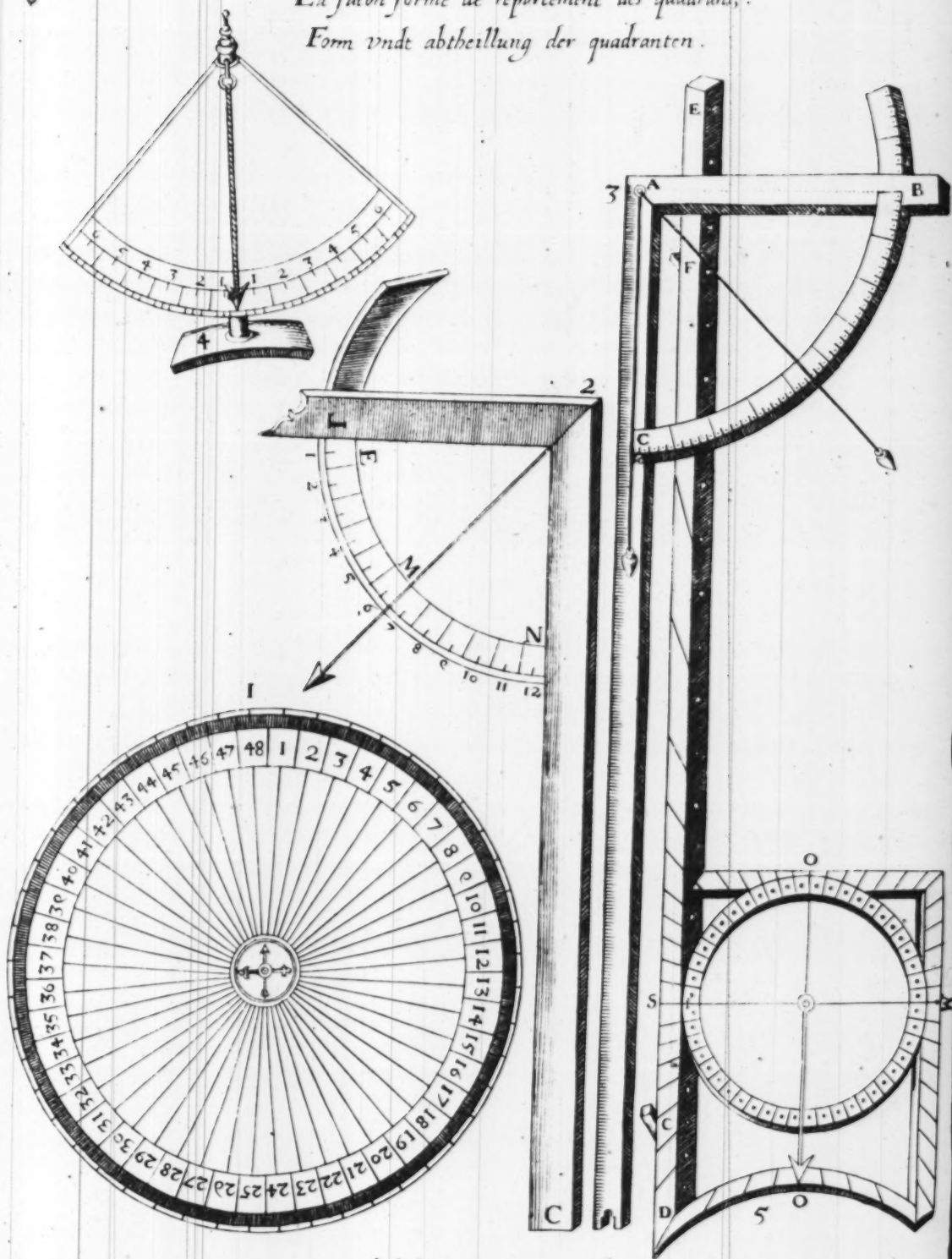
side hath twelue Inches of assize, each diuided by Paralells and Dianonall lines, into 100 equall parts, distinctly to take any Number from 1 to 1000, from thence, with a paire of Compasses. The third, hath Sinicall and Logarithmall deuisions, exceeding necessary for the *Gunnners* practise, as hereafter shall more plainly appeare. The fourth, hath deuisions proportionall to the right Ranges and Randons of any Peece of Ordinance vpon any Mounture from degree to degree; and the number of Inches that any Peece betweene 6 and 15 foot long requireth to mount her to any degree of mounture, vnder 20 degrees, as well or better then by the Quadrant; as the Table following will also explaine.



Tractat. 3. cap. 13 fig. 1

La facon forme de reportement des quadrants.

Form vndt abtheilung der quadranten.





CHAP. XXXII.

*Of the rule of Callibres, and of the difference betweene the heights of the Bore and Shot for any Peece, which is called the vent or due abatement to shoote with safety, and most aduantage therewith.*



INASMUCH as it is an excellent quality in a Gunner to be expert and ready in the Heights and Calibres of Bore and Shot for Ordnance, and to retaine them in memory, rather by reason then by roate, they being the ground and Scale from which all the Measures and Proportions for all parts, as well of the Peece and her Carriage, as of the Powder, Shot, and distance, or the way of the Shot are deriued and vnderstood, as by the precedent & sequent discourses may appeare: But because most English Gunners haue hitherto generally as well for the greatest as the smallest, or meane sorts of Ordnance chosen the Shot for them all, one quarter of an inch lower then the height of their Bores; which the best experienced Gunners of late yeares disliking, haue for a generall proportion chosen rather one twentieth part of the height of the Bore to be abated for a due height of the Shot vent, affirming that in the Faulcon and small peeces the abatement of  $\frac{1}{4}$  of an inch is too much, and for the Canon  $\frac{1}{4}$  of an inch is too little, and that  $\frac{1}{10}$  of the Diametre of the Bore will be a reasonable abatement for all Peeces, be they higher, or lower, which being by Arithmatick so easily found, will not require any example.

CHAP. XXXIII.

*Of the Gunners, Quadrant, and Triangle, with their Degrees and Poynts, whereby either to Leuell, or else to Mount, or Imbase any Peece of Ordnance, to any degree or poynt assigned.*



THE Gunners Quadrant is a Geometricall Instrument, made of brasfe or fine grained wood, containing in the circumference one quarter of a circle, diuided into 90 equall parts or degrees in the outmost limbe, and in the second limbe within into the 12 poynts of the Gunners quadrant, hauing within the same also a Geometricall Quadrate, with each side diuided into 12 equall parts, and those each of them subdiuided by meanes of



parallels and Dyagenalls into 10 equall parts, so that each side will be thereby found distinctly deuided into 120 equall parts, fitly seruing to take all Geometricall Mensurations, of distances, heights, breadthes, and depthes, accessible and inaccessible, by the directions hereafter mentioned. The degrees and also the poynts being principall helpes for the *Gunniers* practise, to shoote at the most certainty both by the right line, and also vpon the advantage of any Randon to and at any Marke assigned, to a probable or assured good effect, as by the Tables, Scale, and directions following, will more plainly appeare, and by the 21 Figure hereof marked  $\times$  wherein each Quadrant, (but that which is marked with 4) hath a strait Ruler about 2 foot long, ioyned either firmly, or by a Groue doue-tayled vnto one of the sides or Semidiametres thereof. Now to plant any Peece leuell, hauing put the said Ruler in close vnto the lower side of the Mettall, within the Concaue Cillinder of the Bore thereof, then mount or imbase the Peece in her Cariage, vntill the plummet fall directly vpon the other side of the Quadrants fiduciall edge, by meanes of drawing out, or putting in the Quoynes as reason will direct you: so will the Axis of the Bore or Concaue Cillinder thereof, bee found to lye directly leuell, or paralell to the Horizontall plane: you may also without a Quadrant leuell any Peece duly founded by holding a plumb line vpright afore the mouth of the Peece, and mounting or imbasing her by meanes of her Quoynes, vntill the line shall appeare only to touch the Flat of the Mettall at the mouth aboue, and below alike: So will the Axis of the Soule that is to cut the flat of her mouth at right Angles, the plumb line being paralell or equi-touching, the same flat be found to bee paralell to the plane of the Horizon, or truly leuell as was required: But if by the said Quadrant you would mount the peece to any degree or poynt of the Quadrant, then you are to mount or imbase her in her Cariage, by drawing or putting in of her Quoynes more then before so much, vntill the plumb line of the Quadrant appeareth freely (the Ruler being put into her mouth as before) to hang directly ouer the degree or point assigned. And the like may be said concerning the imbasing of any peece; as in the 21 Figure  $\alpha$  at 2 for the 12 poynts and at 3 for the 90 degrees  $ABC$  and  $EMN$ , And also concerning the leuell at 4, to leuell peeces, and to finde the vpper part of the mettall: And lastly, to mount and imbase the peece by the helpe of the plumb line; And by the whole circle at 5, deuided into 48 equall parts, making in each Quadrant thereof the 12 poynts of the Gunners quadrant. The like may be done with the sight Rule, by the Table hereof.

#### CHAP. XXXIII.

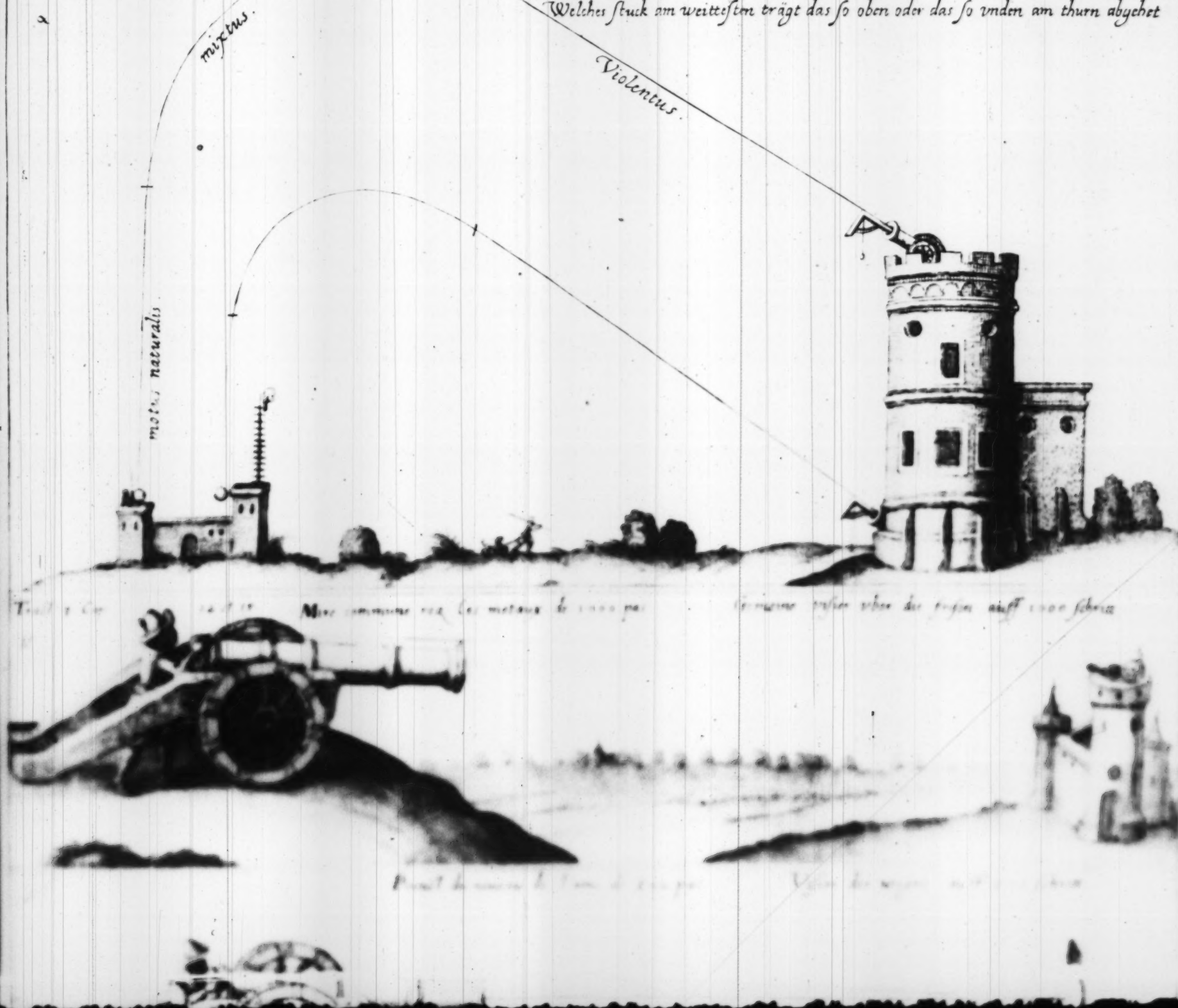
*Of a new deuise by any Staffe, to leuell, mount, and imbase any Peece.*



Also any Peece may with a field *Linstock*, *Rammer*, or *Sponge*, or other *Staffe* be mounted to any degree of the Quadrant, being thus prepared: First, marke from one end of that Staffe a distance, equall vnto the height of the Pomell or Caskabell of the Peece placed



Quelle piece sera de plus lointaine portee celle du hault ou celle du pied d'une tour.  
Welches stück am weittesten trägt das so oben oder das so unten am thurn abgehét





parallels and Dyagenalls into 10 equall parts, so that each side will be thereby found distinctly deuided into 120 equall parts, fitly seruing to take all Geometricall Mensurations, of distances, heights, breadthes, and depthes, accessible and inaccessible, by the directions hereafter mentioned. The degrees and also the poynts being principall helps for the *Gunniers* practise, to shoote at the most certainty both by the right line, and also vpon the advantage of any Randon to and at any Marke assigned, to a probable or assured good effect, as by the Tables, Scale, and directions following, will more plainly appeare, and by the 21 Figure hereof marked  $\propto$  wherein each Quadrant, (but that which is marked with 4) hath a strait Ruler about 2 foot long, ioyned either firmly, or by a Groue doue-tayled vnto one of the sides or Semidiametres thereof. Now to plant any Peece leuell, hauing put the said Ruler in close vnto the lower side of the Mettall, within the Concaue Cillinder of the Bore thereof, then mount or imbase the Peece in her Cariage, vntill the plummet fall directly vpon the other side of the Quadrants fiduciall edge, by meanes of drawing out, or putting in the Quoynes as reason will direct you: so will the Axis of the Bore or Concaue Cillinder thereof, bee found to lye directly leuell, or paralell to the Horizontall plane: you may also without a Quadrant leuell any Peece duly founded by holding a plumb line vpright afore the mouth of the Peece, and mounting or imbasing her by meanes of her Quoynes, vntill the line shall appeare onely to touch the Flat of the Mettall at the mouth aboue, and below alike: So will the Axis of the Soule that is to cut the flat of her mouth at right Angles, the plumb line being paralell or equi-touching, the same flat be found to bee paralell to the plane of the Horizon, or truly leuell as was required: But if by the said Quadrant you would mount the peece to any degree or poynt of the Quadrant, then you are to mount or imbase her in her Cariage, by drawing or putting in of her Quoynes more then before so much, vntill the plumb line of the Quadrant appeareth freely (the Ruler being put into her mouth as before) to hang directly ouer the degree or point assigned. And the like may be said concerning the imbasing of any peece; as in the 21 Figure  $\alpha$ , at 2 for the 12 poynts, and at 3 for the 90 degrees *ABC* and *EMN*, And also concerning the leuell at 4, to leuell peeces, and to finde the vpper part of the mettall: And lastly, to mount and imbase the peece by the helpe of the plumb line; And by the whole circle at 5, deuided into 48 equall parts, making in each Quadrant thereof the 12 poynts of the *Gunniers* quadrant. The like may be done with the sight Rule, by the Table hereof.

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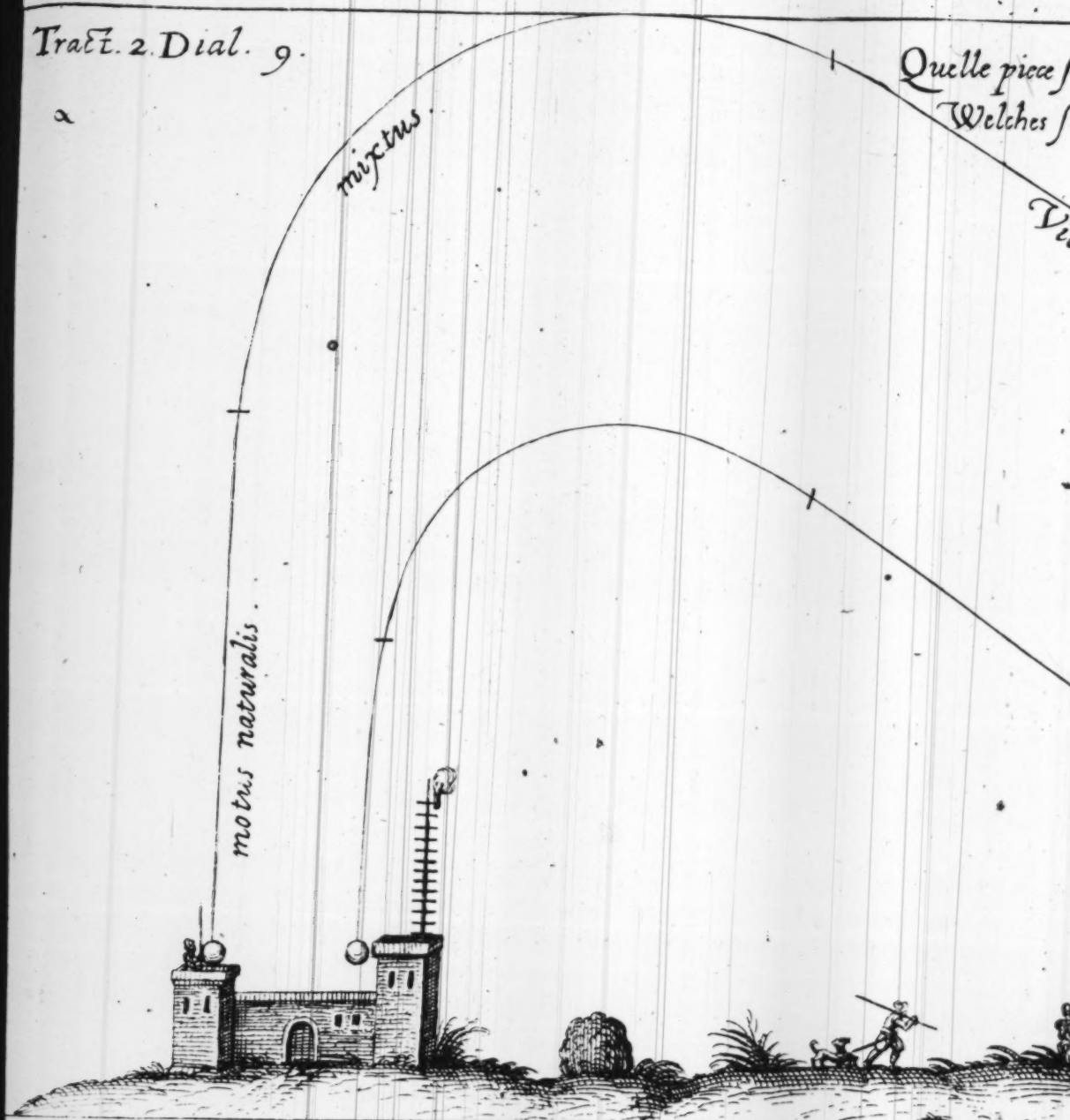


Tract. 2. Dial. 9.

a

Quelle piece  
Welches

Vi

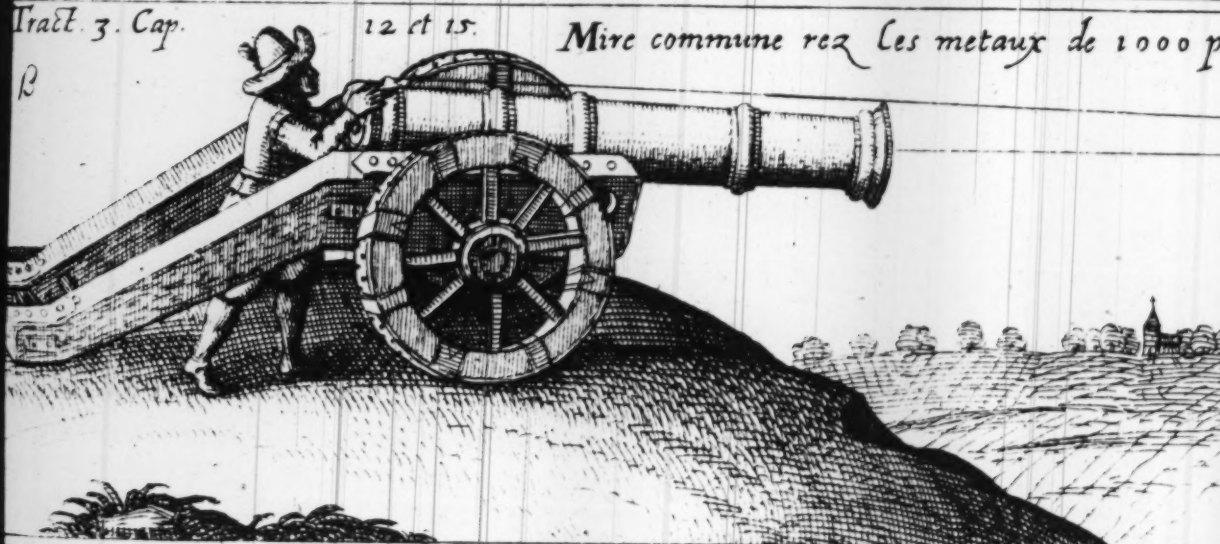


Tract. 3. Cap.

B

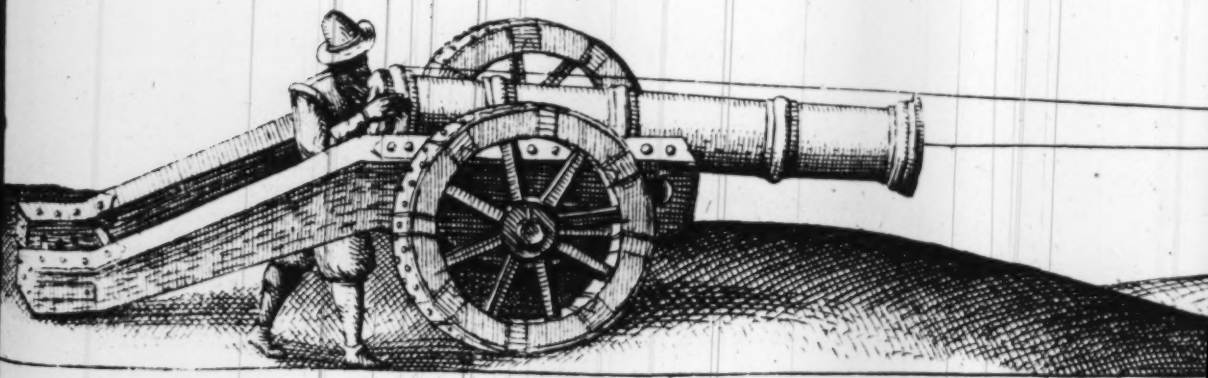
12 et 15.

Mire commune rez les metaux de 1000 p



11

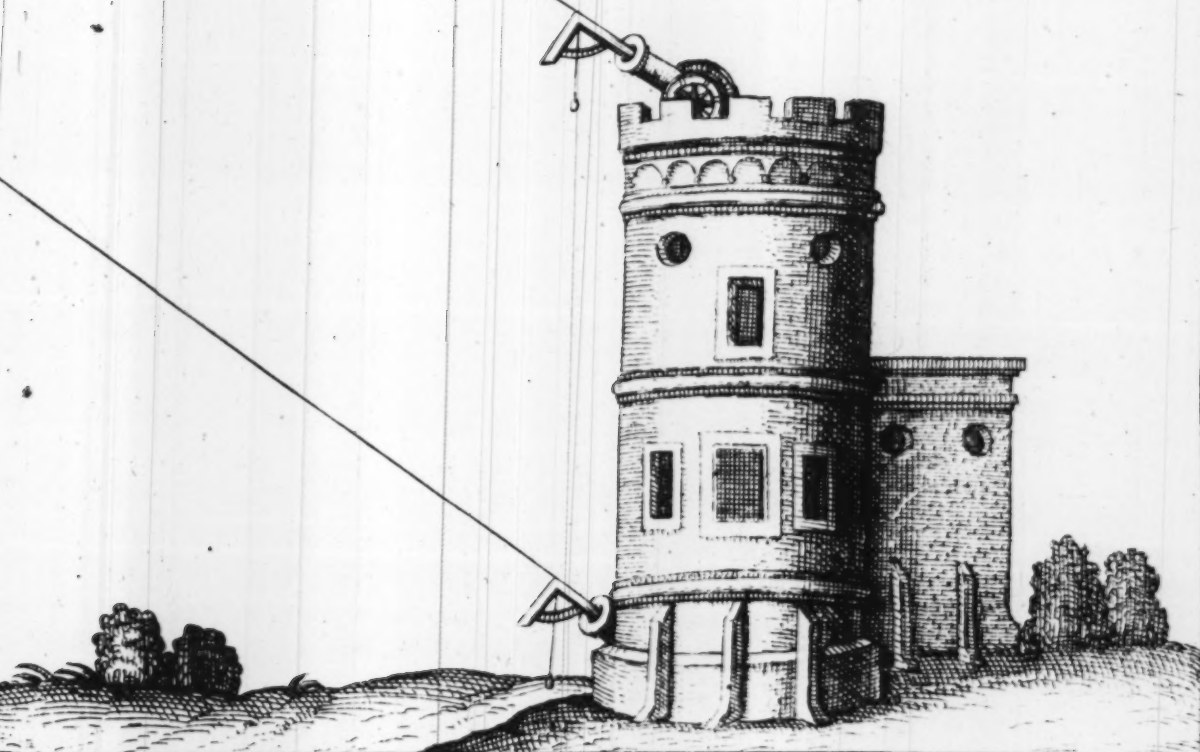
Poinct du niveau de l'ame de





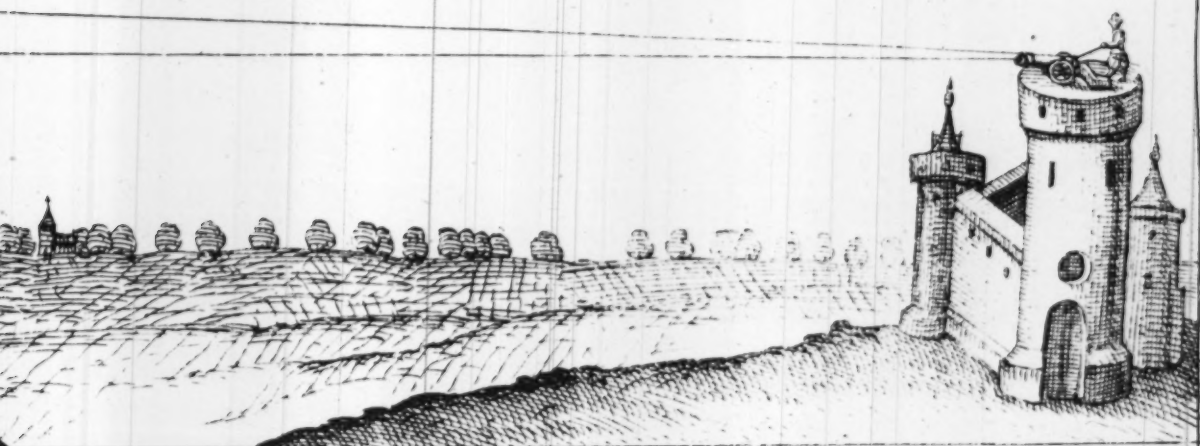
piece sera de plus lointaine portee celle du hault ou celle du pied d'une tour.<sup>7</sup>  
 welches stuck am weittesten trägt das so oben oder das so vnden am thurn abgehelt

*Violentus.*



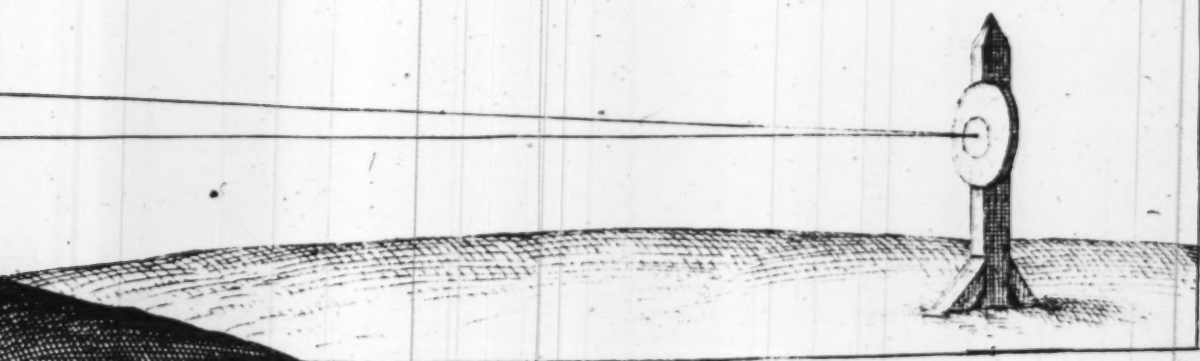
1000 pas.

Gemeine visier vber die frisen auff 1000 schritt.



ame de 500. pas.

Visier der wogen auff 500 schritt.





placed leuell vpon her Platforme, and then take the distance betwene the Centre of the Trunions and the Pomell or Caskabell, which make or imagine a semidiameter of a Circle, and diuide it by Dyagonalls and Paralels, or otherwise into 1000 equall parts. Lastly, out of the Table of *Sines*, take the number answering vnto euery degree out of the said 1000 parts, and set that distance from the said marke downwards. And if the totall *Syne* of the Table be 100000, omit the two last figures of each number thereof towards the right hand, and if it be 10000000, then omit foure figures of each number you finde in that Table, and the remaining number will shew how many of those 1000 equall parts are to be set downwards from the marke beneath the said leuell for each seuerall degree: Then drawing also 10 Paralels and Dyagonalls from the first degree to the second, and from the second to the third, &c. successiue continued from each to his next, noting euery degree with Arithmetical characters, so may you from 6 minutes to 6 minutes by those right synes mount the Peece, so set forth for any Peece which it shall be prepared for. This may also be described vpon such a staffe without the Table of synes in a mechanicall manner thus: If you describe a Quadrant or Quarter of a circle with a semidiameter, equall to the distance from the centre of the Trunions, to the centre of the Pomell or Caskabell, and deuide the Arch of that quadrant into 90 equall parts or degrees, and then from each degree, letting a right line fall perpendicularly vpon the base side of the said quadrant. And lastly, each of those right lines being thence transferred from the said first marke downwards vpon the said staffe, and marking them with Arithmetical figures for each degree, thereupon making also Paralels and Dyagonalls, as aforesaid you may thereby Geometrically and mechanically marke the same from 6 to 6 minutes as before. The vse of them are plaine and easie, for if you bring downe the centre of the Caskabell or Pomell of the Peece to any number of degrees thereon, so marked, for that peece, you setting the lower end of the staffe to the Platforme being euen, although it be rising or descending backwards: I say then the Axis of the bore of that Peece will be found to be eleuated vnto the degree assigned: If you bee to imbase the Peece, those lynes and number also set about the first named marke, will performe the like office there in the thing required.

CHAP. XXXV.

*How to finde the right line or right range of any Shot discharged out of any Peece, for euery eleuation, by any one Right or dead Range giuen for the Peece assigned.*

**I**F the Range giuen be the right Range, say by the Rule of three if the Tabular number found in the Table of dead Ranges for the degree of the Range giuen, giue the number of knowne measures in that Range: what shall the Tabular number of the Table of right



right Ranges, proper to the degree assigned giue. And having multiplied and deuided them duly, the fourth number will be the right Range, or right line for the Peece sought.

*Example 1.*

**S**Vppose you are to seeke the right Range of 30 degrees for that Peece, whose dead Range for 30 degrees is giuen or knowne to be 2200 paces by it, multiply the Tabular number of right Ranges for 30 degrees, which is 693, and diuide the product by 2150, the Tabular number for 30 degrees in the Table of dead Ranges, and the Quotient will bee 711 paces for the line or right Range of that Peece, mounted and discharged at 30 degrees eleuation.

*Example 2.*

**S**Vppose the leuell right Range is giuen, and the right Range for 30 degrees mounture bee sought, say, if 192 the first number in the Table of right Ranges, giue 693 the Tabular number thereof for 30 degrees, what shall 197 paces the leuell right Range giuen giue, multiply the third by the second, and deuiding by the first, and the Quotient, will be 713 paces for the right Ranges sought, the difference is that Tables cannot be so exactly calculated, but by omitting small fractions, small differences will grow apparant, by working one question or *example* diuers wayes, which let suffice.

CHAP. XXVI.

*To finde how much of the Horizontall line is contained directly vnder the right line, or right Range of any Shot, made out of any Peece at euery eleuation assigned.*



Aving by the last Chapter found the number of paces, the Peece will carie her Shot in a right line being duly discharged, at any Eleuation assigned, multiply the same by the right Sine of the complement of the degree of Mounture, and deuide the product by the whole Sine, and the Quotient will bee the number of paces (or such like measures) containd in the leuell, directly vnder the right Range sought.

*Example.*

**B**E it propounded how to finde what part of the Horizontall line lyeth, directly vnder the right Range of the Peece assigned at 30 degrees eleuation, the right Range at 30 grades by the precedent, being found to bee 713 paces, and the right sine of 60 grades, the complement of 30 being 866, being

being multiplied together, and the product deuided by 1000, the whole line leaueth in the Quotient 617, for the number of paces lying directly vnder the right Range sought.

CHAP. XXXVII.

To finde how much of the Horizontall line lyeth vnder the crooked Range of a Shot, made out of any Peece at any Eleuation assigned.



He *crooked range* is so much as the course or way of the Shot, as it goeth helically betweene the right Range, and the naturall or perpendicular motion, or before it make the first graze; And may bee thus found either by deducting of the leuell distance contained directly vnder the right line or right Range of any Shot made, (found by the last Chapter) out of the dead Range thereof found by the Chapter before-going: For the remainder will be the paces or other measures, lying directly vnder the *crooked range*.

Example 1.

THE Peece supposed to be mounted to 30 degrees, is found to conuey the Shot 2100 paces to the dead range or first graze of the Shot, and it also conuayeth the Shotte 617 paces in the leuell vnder the right Range, which deducted out of the said dead Range, there remaineth 1683 paces, which lyeth directly vnder the *Crooked range*, in the Horizontall line the thing sought.

CHAP. XXXVIII.

Of the violent, crooked, and naturall motion, or course of a Shot discharged out of any Peece of Ordnance assigned.



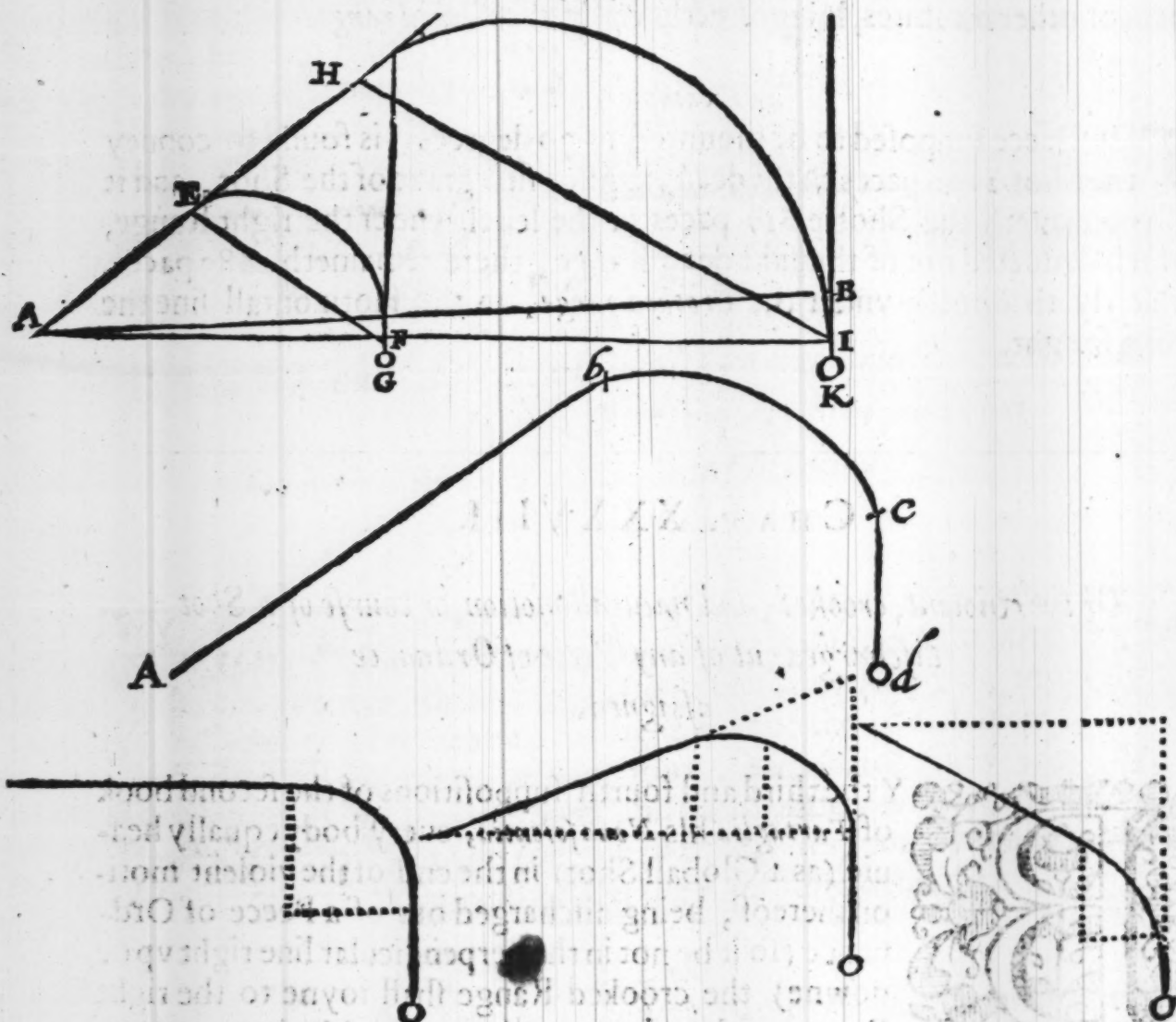
BY the third and fourth suppositions of the second book of *Fartaglia his Noua scientia*, every body equally heauie (as a Globall Shot) in the end of the violent motion thereof, being discharged out of a Peece of Ordnance (so it be not in the perpendicular line right vp or downe) the crooked Range shall ioine to the right Range, and to the naturall course or Motions, and bee betweene them both: So for example, the right Range being all the line *ab* of the Figure following, and *cd* the naturall motion. He



He saith  $BC$  will being the mixt or crooked Range loyne, and bee contingent to them both in the poynts  $b$  and  $c$ , wherein  $c$  will be the furthest part of the crooked course or range from the Peece so directed, and  $d$  the end of the naturall motion thereof.

And in his seauenth proposition of the same booke hee prooueth, That euery Shot equally heavy great or little, equally eleuated above Horizon, or equally oblique or leuellly directed, are among themselves like and proportionall in their distances, as the Figure following sheweth: as  $AEF$  is like and proportionall in the right and crooked Ranges, vnto  $AHI$ , and in their distances or dead Ranges  $AF$  vnto  $AI$ .

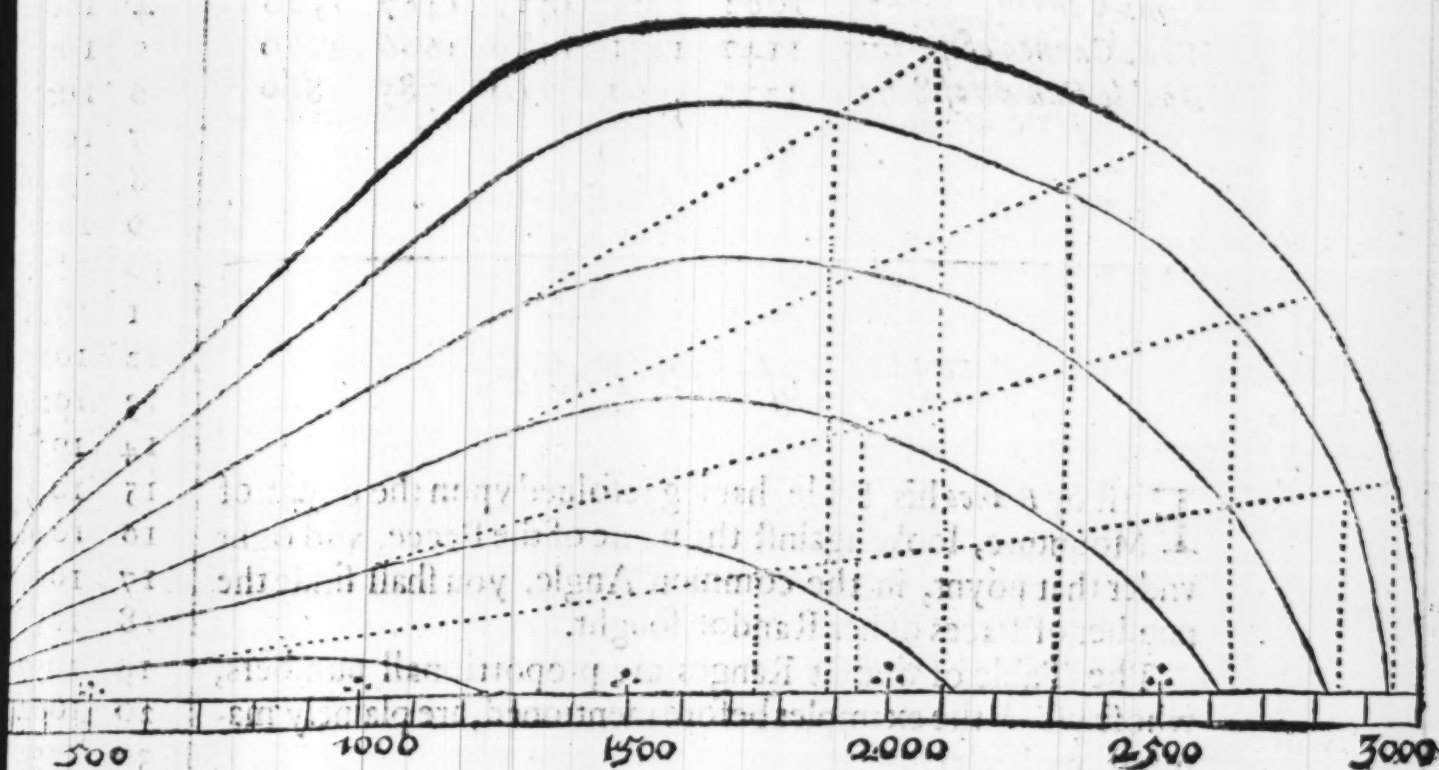
And in his fourth, fifth, and sixth propositions of the same booke, he pro- ueth that euery Shot made vpon the leuell, hath the crooked range thereof equall to the Arch of a Quadrant, or quarter of a Circle; and if it bee made vpon any eleuation above the leuell, that then it will make the crooked Range to be more then a Quadrant, and that if it be made imbaled vnder the leuell, that then the crooked Range thereof will be an Arch lesse then a Qua- drant, as the three last figures following doe represent.



And



And lastly in his ninth Proposition of the same booke, he vndertaketh to proue, if one Peece be shot off twice, the one leuell and the other at the best of the Randon, that the right Range of the leuell, is but one quarter of the right Range of the best: And that the dead Range of the leuell is but  $\frac{1}{10}$  of the dead Range of the best Randon, whereto he that desireth further demonstration, may haue recourse, and examine his demonstrations of those propositions in his said second booke of his *Noua Scientia*. *A Diagram for the Randons of a Saker upon each of the first six Points, according to Alessandro Bianco.*



Now to finde at what distance from the platforme whereon the Peece is to be discharged, the course of the Bullet will cut the aspect of euery Mounture (which will helpe when a marke shall bee without the right Range of the Peece in the aspect of its eleuation, aboue the Horizon) to make a faire Shot at first by taking a greater aduantage of mounture: as suppose a Marke eleuated 15 degrees, to be distant 700 paces.

By the last Diagram open the Compasses, vntill the aspect cut the poynt of Mounture, then applying the same vnto the scale vnder it, you shall thereby finde at what distance it cutteth the Randon required.

*Alexander Bianco his Table of Randon's for the sixe  
first Poynts reduced.*

|                            | 1   | 2    | 3    | 4    | 5    | 6    |
|----------------------------|-----|------|------|------|------|------|
| <i>Falcones.</i>           | 375 | 637  | 795  | 855  | 892  | 900  |
| <i>Falcon.</i>             | 550 | 935  | 1166 | 1254 | 1309 | 1320 |
| <i>Minion.</i>             | 450 | 765  | 954  | 1026 | 1071 | 1080 |
| <i>Saker.</i>              | 625 | 1062 | 1325 | 1425 | 1487 | 1500 |
| <i>Demi-Culvering.</i>     | 725 | 1232 | 1537 | 1653 | 1725 | 1740 |
| <i>Culvering.</i>          | 750 | 1275 | 1590 | 1710 | 1785 | 1800 |
| <i>Demi-Cannon.</i>        | 625 | 1062 | 1325 | 1425 | 1487 | 1500 |
| <i>Whole Cannon of 7.</i>  | 675 | 1147 | 1431 | 1489 | 1606 | 1620 |
| <i>Double Cannon of 8.</i> | 750 | 1275 | 1690 | 1710 | 1785 | 1800 |

*A Table of  
secant ran-  
ges.*

|    |          |
|----|----------|
| 0  | 1000     |
| 1  | 1000     |
| 2  | 1000     |
| 3  | 1001     |
| 4  | 1002     |
| 5  | 1003     |
| 6  | 1005     |
| 7  | 1007     |
| 8  | 1009     |
| 9  | 1013     |
| 10 | 1015     |
| 11 | 1018     |
| 12 | 1023     |
| 13 | 1026     |
| 14 | 1030     |
| 15 | 1035     |
| 16 | 1040     |
| 17 | 1045     |
| 18 | 1051     |
| 19 | 1057     |
| 20 | 1064     |
| 30 | 1154     |
| 40 | 1305     |
| 50 | 1555     |
| 60 | 2000     |
| 70 | 3923     |
| 80 | 5758     |
| 90 | Infinite |

*The vse of these Tables.*

**F**irst by *Bianco* his Table, hauing resolued vpon the poynt of Mounture, looke against the name of the Peece, and right vnder that poynt, in the common Angle, you shall finde the number of Paces of her Randon sought.

The Table of Secant Ranges are proportionall numbers, whose vse by the examples before mentioned, are plainly manifest, which let suffice.



CHAP. XXXVIII.

How to load a Peece of Ordnance Gunner-like.



He Peece being mounted, and duly planted on his Plat-  
forme, and well provided with all things in readinesse for  
service, as of powder, Shot, Ladle, Spunge, Ramer, Wad-  
hooke, Wadds, and Tampions. The Gunner must place his  
Linstock to Lee-wards; or vnder the winde, and hauing  
cleared the peece and Touch-hole, he must sponge his peece  
very well standing on the right side of the peece, and drawing out his  
Spunge, let him giue it two or three blowes vpon the Mouth on the out-side  
of the peece, to beate off the foulness and dust it hath gathered within:  
then his assitant declining the powder or boudge barrell aside, he shal thrust  
in his Ladle to fill it, striking off the heaped powder, giuing a shogge to shake  
downe the surplusse: and it being so filled and striked, put in the Ladle  
downe to the bottome of her Concaue Cillinder vnto the Touch-hole,  
but at the first putting of the Ladle (so filled) into the Mouth of the peece,  
slide in the Ladle staffe, so that the vpper side may keepe vppermost all the  
way, and when it is arriued to the bottome of the Bore, then hee laying his  
right thumb vpon the said vpper side of Ladle staffe, neere the Mouth of the  
peece, and turning the said staffe so much, vntill the said thumb vnremoued  
vpon the staffe be found directly vnder the same; then giuing two or three  
shakes, and bearing vp the Ladle, that the powder may bee turned out, or  
goe out cleane, and that the Ladle bring no powder back therewith, for  
that were a foule fault for a professed Gunner to commit. Then shall he put  
the powder home softly, with the Rammer that is at the end of the Ladle  
staffe; putting in a good Wadd, and thrust it home to the powder, giuing  
three or foure hard strokes, which wil gather the scattered powder together,  
and driue close the same, and the rest to the bottome of the Chamber the  
Assitant, hauing a finger vpon the Touch-hole all the whilst: And then  
put in the Shot which with a Rammer he must put softly home, and after-  
wards another Wadd of Hay, Grasse, Weedes, Okham, or such like: And  
againc, giue two or three good strokes with the Spunges Rammer head:  
But if the Peece doe require two or three Ladles of powder, it must bee all  
put in before any Wad, in that maner as the first was mentioned, and so in all  
other things. And then place the Boudge or powder barrell to wind-wards,  
and couer it safe with some Hide, garment, or cloath: alwayes auoyding  
to stand before the mouth of the Peece, but on the right side thereof in  
loading her for feare of further danger. And lastly, the Peece is to bee layd  
to the marke and prymed and fired, and so will his Peece said to be loaded  
Gunner-like.



## CHAP. XXXIX.

Whether the longer Peeces out-shoot the shorter, and why the  
Culuerings shoote farther then the Cannon and the  
Demy-Culuering then the whole

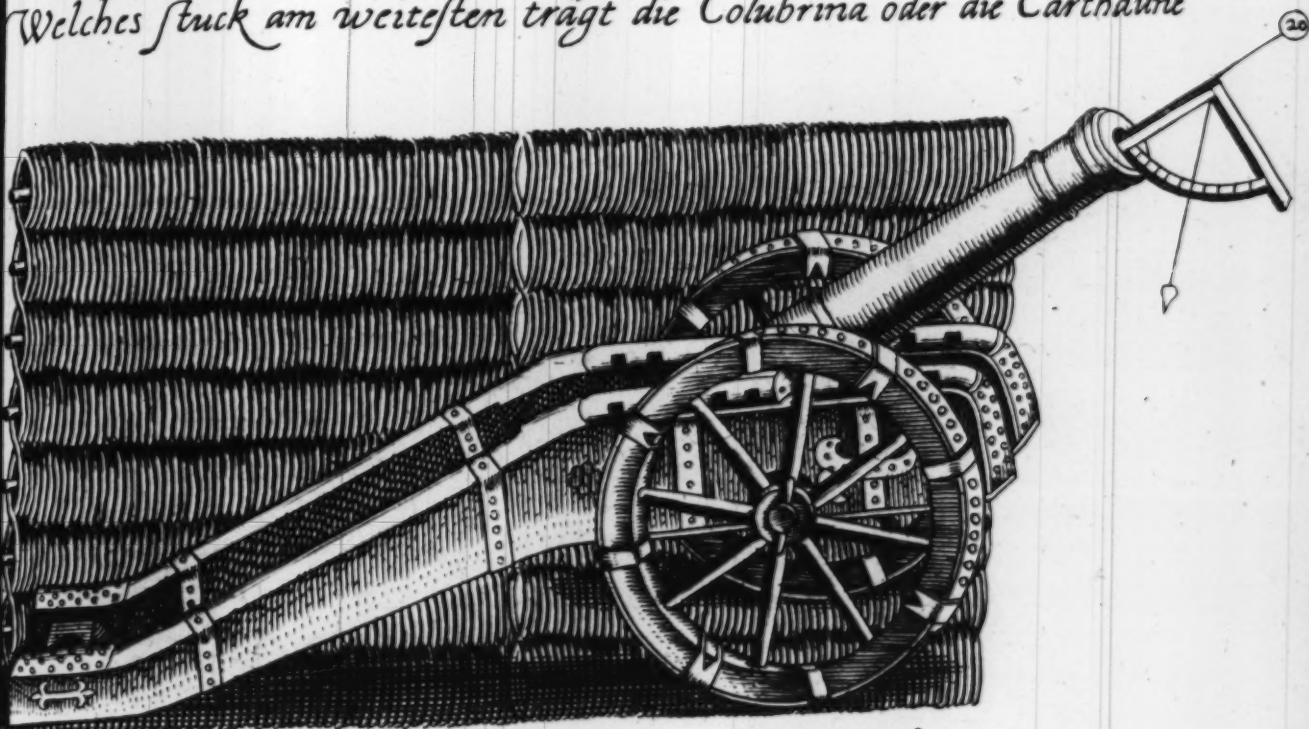
Culuerings, &c.



Euethelisse, that the eighth Theorem of this booke  
affirmeth, that *The longer the Peece the stronger the stroke,*  
which is most true, yet must it require this moderation,  
that all proportions be agreeable in the longer Peeces,  
namely that the proportion of the height of bore, and  
fortitude of mettall, and charge of powder, be corre-  
spondent one to the other, as in my Exposition vpon  
one of Mr. Digges his Questions is related: For if the  
Fortitude of mettall be wanting, and so vnable to resist the force of powder  
due to load your Peece withall, in respect of her length & height, so that the  
Shot may be come iust to her Mouth in that instant, that all the Powder shall  
be perfectly fired, or that by reason of her shortnesse (she hauing fortitude)  
the Shot be gone out before the powder in her be all perfectly fired, there is  
neither of them both can performe so much as they otherwise would doe, if  
their proportions of height, length, and fortitude had beene correspondent  
one to another. And there must also bee a respect had vnto the force of the  
powder vsed, that there may bee a conuenient correspondencie betweene  
the proportion of it to the rest: For otherwise, a Peece being loaded with a  
proportionall Charge of worser powder, may shoote further, then if shee  
were loaded with as much in waight of better powder, by reason of the dis-  
proportionalities afore said. It was experienced, as *Luigo Coluado* in his 21  
*Chapter* mentioneth, that an extraordinary Culuering of 48 Dyameters of  
her bore in length, being loaded with a Charge of powder vsually allowed  
to Culuerings (proportioned to the waight of her Shott) did shoote fewer  
paces, then afterwards when 8 dyameters of her length was cut off from her  
Mouth to her Breach wards. And then also 6 dyameters more being like-  
wise cut off, and in like sort, shee being loaded and discharged at the third  
time, conuayed her Shot farther then either at the first or second, whereby  
and by the 14<sup>th</sup> Theorem hereof, with the said exposition, all will most plainly  
appeare both Theorically and Practically: But the olde error of the Rule  
of Flat, as some Gunners haue called it, and taught it to others: I thought  
fit to warne you of being a sight Rule, deuided into inches, to set on the  
breach of any Peece, to mount her to any angle vnder 30 degrees, by a like  
certaine number of inches, and parts, for Peeces of all lengthes, which is not  
onely impossible, but also absurd: As I haue shewed before in the 76 Page,  
where I shall speake of the good vse that may be made of the inch Rule for  
that purpose, with my Table for the same in the 93 Page.

Tract. 2 dial. 20.

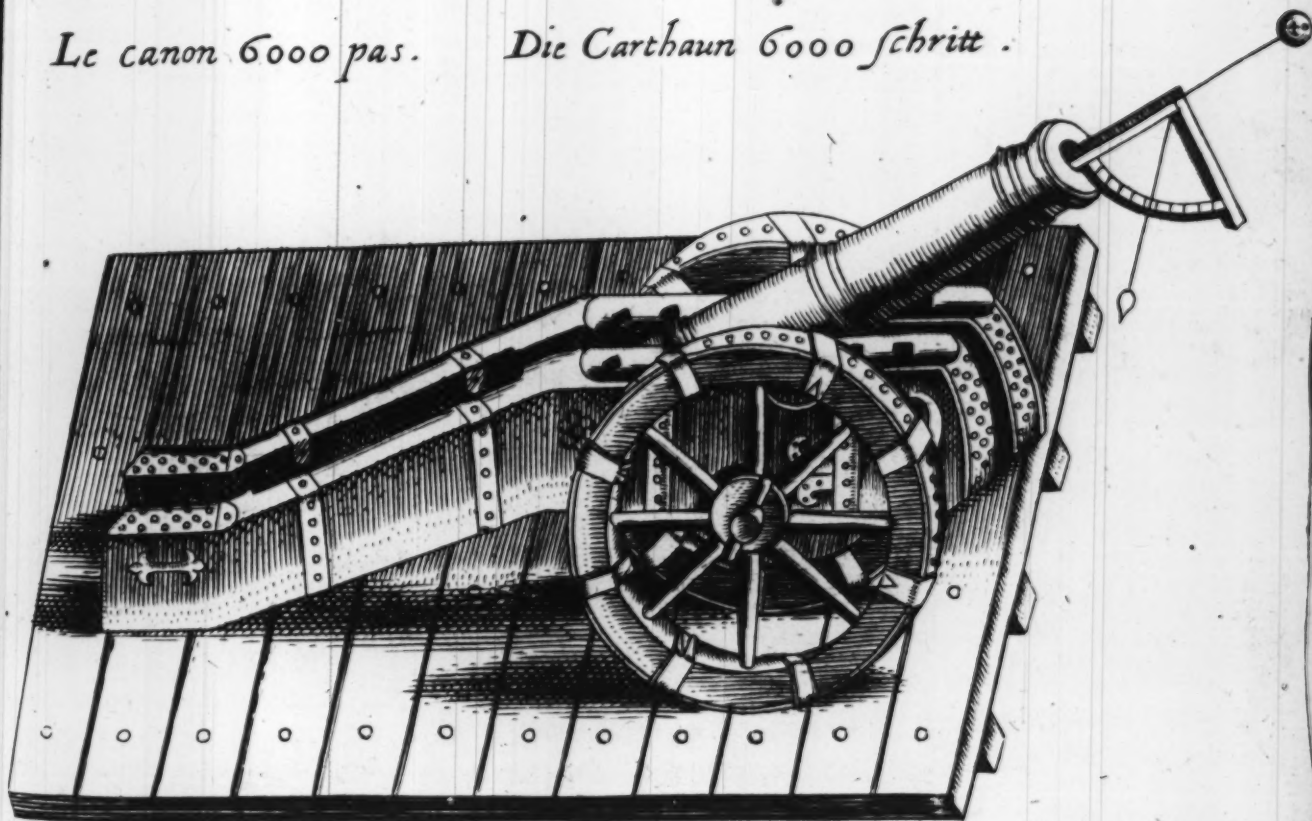
Quelle sera de plus grande portee la Colubrine ou le Canon.  
Welches stuck am weitesten trägt die Colubrina oder die Carthaunē



En tel point la Colubrine portera 7000 pas. quelq. peu plus ou moins.  
In solcher erhöhung trägt die Colubrina vngeschrlich 7000 schritt.

Le canon 6000 pas.

Die Carthaun 6000 schritt.







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CHAP. XL.

Of shooting *Mira Comune*, or by the *Mettalls* of the *Peece*, and  
the difference betweene shooting so, and  
by the *due dispart*.



Although the difference of making a Shot to a Marke, by the highest of the *Mettall* at her breech and muzzle, and by the continued aspect of the Axis of her bore, is so uncertaine, according to the length of the *Peece*, and the differences betweene the Diameter of the Base and Muzzle Rings, that no certaine proportion can be generally assigned: yet for most *Peeces* it hath bene well obserued, that the *Peece* directed by her *Mettall*, will shoote about twice as farre, when the Marke is leuell, or the sight line being paralell to the Horizon, as it will doe vpon the laying it leuell by the dispart Quadrant, or Axis of her Bore, the incertainty thereof depending vpon the Angle, it maketh more or lesse aboue the Horizon, which for each *Peece* may best be found, by the differences of the disparts of seuerall *Peeces* that are of equall lengthes, but is accepted or guessed to be generally to shoote twice the distance *Mira Comune*, as it will doe vpon the true leuell Axis: But that Rule is seldome exact, for the difference is sometimes five gr. and other sometimes seauen degrees, and sometimes neither, euen as the Mounture vpon the *Mettall*, & the leuell of the Axis will (being precisely examined) make manifest. And therefore to shoote with any *Peece Mira Comune*, or by the *Mettalls*, the difference or Mount about the leuell, which the mettall causeth being considered, and exactly examined, will shew the Angle of the *Peeces* Mounture, with which you must repayre to the following Tables of proportionall Mountures, for the seuerall Randons vpon each poynt or degree of the Gunners Quadrant, which is thus easily to be appropriated vnto any *Peece*, hauing made one Shotte with her at a Mounture certaine, and finding her proper dead Range for the same, which reuered to the given Eleuation, will soone yeeld the Range required. As for example, suppose that by examination it be found out, that by reason of the randoes or emiencie of the Muzzle ring, and length of the Chase of the *Peece*, the direction by the *Mettalls* at the Breech and Muzzle ring, to mount the *Peece* higher then it would, if the Axis of her Bore were duly directed by a true dispart, vnto any Marke assigned by fixe degrees, and let it be imagined that the Marke is eleuated fixe gr. aboue the Horizon, so found by the Quadrant: And lastly, let it bee giuen at that mounture, the *Peece* did shoote 850 paces for her dead Range: the question is, how farre the same *Peece* would conuay the like Shott with like loading and accidents, if she were by the highest of her *Mettalls* at Breech and Muzzle, directed to the same Marke. Say then if 722, the number in the Table of dead Ranges against fixe gr. giue 850 paces, the measure of the Shott made in her at fixe

degrees mounture, what shall 1394 the number against 12 degrees mounture giue, multiplying the third of these three numbers by the second, deuiding the Product by the first, the Quotient 1534 paces, will so much better answere to the question then Mr. *Smithes* rule can doe.

## CHAP. XLI.

*Of shooting by the Dispart or Axis of the Bore (in right bored Peeces, called by some Gunners erroneously the poynnt Blanke) as farre as it curreth a Shot in a right line.*



His kinde of shooting called (poynnt blanke) is so farre as a marke is within the strait line of the Peece, which for some *Elevations* or Mountures, is much more then for others, for that the more a Peece is mounted, the farther she conuayeth her Shot in the right range, except it could bee shot perpendicularly downwards, which (as I haue already in my first booke called, *The Art of great Artillerie* shewed) may therefore in Peece giuen, yeeld infinite poynnt blankes. But bee the Mounture giuen, and the mark within the right line, or right Range of the Bullets course (that is within that space of the Shots right course) as it may be said to goe strait (or insensibly crooked) or so farre as it accompanieth the continued Axis of the Mettal, in right bored Peeces, or of the Soule in the wry bored (which is the cause that in such a Shots there is more seldomer failing, then in any other manner of shooting whatsoener) this kinde of shooting being made by the Dispart, so maketh the *error* to be no more then the distance betweene, the visuall line directed from the middle poynnt of the said Axis, and the visuall line that passeth from the Gunners eye, except accidents cause the contrary, it being directed by the highest of the Mettall of the Base ring, and by the top of the dispart vnto the assigned Marke. Now forasmuch as the length of the Peece and the variety of the Powder by the eighth *Theorem*, breedeth the difference of force, swiftnesse, and vehemencie of the Short and stroke of the Bullet: it is therefore impossible to giue generall certaine Rules for the right Ranges, without some experience in that Peece bee first made, found thus.

If many Papers or Cloathes be set in the right line or way of the Shotte, betweene the Mouth of the Peece and the Marke, then making an orderly shotte with a full Bullet directed to some Marke, setting a stick in each place, with the top thereof right in the Centre of the hole which the shotte went through at euery paper: You shall thereby perceiue where the shotte did first begin to decline, and how much at each distance, which being measured, will very much informe the Gunner both for leuell Batteries, and shooting



shooting at randon, and vpon aduantage, in the meane space the Table following will for right ranges helpe.

**A Table of the proportions  
of right Ranges, or  
poynt blanks.**

|    |      |
|----|------|
| 0  | 192  |
| 1  | 209  |
| 2  | 227  |
| 3  | 244  |
| 4  | 261  |
| 5  | 278  |
| 6  | 285  |
| 7  | 302  |
| 8  | 320  |
| 9  | 337  |
| 10 | 354  |
| 20 | 424  |
| 30 | 693  |
| 40 | 855  |
| 50 | 1000 |
| 60 | 1140 |
| 70 | 1220 |
| 80 | 1300 |
| 90 | 1350 |

*The vse of the Table,  
with example.*

Having found by experience that at 6 degrees of Moun-  
ture the Peece assigned Shot  
200 paces in a right, or in-  
fencible crooked line, and  
would know how farre the  
same Peece will shoote in a  
straite line, being mounted  
to 10 degrees, say by the  
Table, if 278 the number,  
against 6 gr. giueth 200 pa-  
ces, what will 354 the num-  
ber therein against 10 de-  
grees giue, 278 paces.

**CHAP. XLII.**

*Of shooting vpon the Aduantage or Randome at a Marke, beyond  
the right line of the Peeces reach, or right Range of the  
Shot: and of the dead Range for any Peece  
at euery degree.*



S in the last Chapter wee haue saide for the right  
Range, so must we also say for the dead Range, which  
consisteth of the addition of the right and crooked  
Ranges together into one, and then called the dead  
Range, which is the whole distance from the Plat-  
forme, vpon which the Peece assigned is discharged,  
vnto the first fall or graze of the Bullet, vpon the le-  
uell line, or Horizontall Plane, by reason the diffe-  
rent lengthes of the Peeces, and strength of the powder encrease or de-  
uinceth the course or fury of the Shot, and therefore more difficult to bee  
found, but only by experience, or by Diagrams, Tables, or Scales made from  
experiments.



experiments, Now although it bee very difficult, and a thing vncertaine also, to ariue herein to exactnesse, without some experiments made with the assigned Peece and Powder: Yet to come to a necessary neerenesse at first (farre surer then by vncertaine guesing) either by the Table, here annexed by my Scale or Rule, grounded vpon often obseruations and tryall, I hauing made 200 shott for it, you hauing the right range, for the Mounture assigned by the former dead Range, of the Shott for the Mounture required. Note where the Shors course cutteth the Angle of euery Mounture, for that Peece and powder giuen in this manner: First, take the right Range of the Peece experimented from the right Range for the Mounture assigned, and diuide the remainder in such reason, as the said Angle of Mounture is to the Angle of the complement thereof, and to the Quotient adde the said right Range found, and the off come thereof, will bee the dead Range for that Peece, Powder, and Mounture assigned. As for example, let it be supposed, that a Peece mounted at 30 degrees, shot 3000 paces in the right Range, and 3000 at the dead Range, I desire to know the dead Range at 40 degrees.

A Table of the proportions of dead Ranges.

| Gr. | Pa.  |
|-----|------|
| 0   | 192  |
| 1   | 298  |
| 2   | 404  |
| 3   | 510  |
| 4   | 616  |
| 5   | 722  |
| 6   | 828  |
| 7   | 934  |
| 8   | 1044 |
| 9   | 1129 |
| 10  | 1214 |
| 11  | 1396 |
| 12  | 1394 |
| 13  | 1469 |
| 14  | 1544 |
| 15  | 1622 |
| 16  | 1686 |
| 17  | 1744 |
| 18  | 1792 |
| 19  | 1849 |
| 20  | 1917 |
| 25  | 2013 |
| 30  | 2185 |
| 35  | 2249 |
| 40  | 2389 |
| 45  | 2396 |
| 50  | 2389 |
| 55  | 2283 |
| 60  | 1792 |
| 65  | 1214 |
| 70  | 722  |
| 75  | 298  |
| 80  | 192  |

To doe this the plainest mechanall way, is to diuide that dead Range into any number of parts at pleasure, which set out in a line, at one end of that right line, make an angle by the 23 proposition of the 1 of *Euclide* demonstrated herein, and from the other end thereof erect a perpendicular line by the 11 proposition also there mentioned, vntil it intersect the line that framed the Angle giuen, and note well how many such parts it containeth, and multiply the parts of the dead Range by the parts, that the line that framed the Angle containeth, and then diuide the product by the number of parts you diuided the line of the dead Range into, and the Quotient will bee the Secant Range, which knowne, (as imagine, for the secant Range was found 1555 paces, and for the dead range 3000 paces giuen) Say if 1555 giue 1000 the whole *sine*, what shall 1000 the dead range giue, 643  $\frac{1}{2}$ , the right *sine* of the Angle, the Peece must be mounted vnto, vpon the advantage, to shoote 1000 paces for her dead range.



Cap.

CHAP. XLIII.

*How to order and direct a Peece, and amend an ill Shott that was made either by the Mettall, leuell, right line, or aduantage, or Mount.*

**I**F leasure will not permit to vse the Ruler and Beuill, then the Gunner may by his iudgement, according to the Charge and proportion of the Peece, take such a marke as he guesseth neereſt, and likeſt to be beſt for the purpoſe; if it prooue to ſtrike on't iuſt, then hee hath his deſire: for vſing like Powder, Shott, and hauing like temper and accidents, he ſhall alwayes make thereby the like Shot. But if the Shott went too high, hee ſhall then direct the peece in like ſort againe, and lay ſome ſmall thing, as diſcretion will guide him vpon the higheſt of the muzzle ring, and bring it and the higheſt of the Baſe ring in one, with the firſt point or marke, doing ſo, or more or leſſe vntill he hit the marke deſired, and the ſame may be tryed by bringing the peece vpon the firſt marke, which without doubt hee ſhall attaine vnto with reaſons Rule as afore. And if the firſt Shott be vnder or ſhort, he muſt doe as before ordering and directing his peece in like manner, ſaving that before the peece be removed, hee muſt lay ſome little thing on the higheſt part of the mettall at the breech, and then by helpe of the Quoynes, ſhee being imbaſed or mounted more or leſſe, as occaſion requirerh, vntill the higheſt of the mettall at the Mouth and Breech with that helpe, and the firſt marke become together into one right line. And ſo is the peece ordered for the ſhooting by *Mira Commune*, vnleſſe fault bee by loading of the powder too much or too little, &c. And although other accidents may miſleade him therein, yet either of thoſe ſaylings are alſo to bee reformed by the Beuill Quadrant represented in the 25 figure. As if the Gunner by the mettall take his marke ſo, that the Shot fall ſhort: To correct the ſame, after the peece at the next Shott, is placed as before, hee may then by the ſaid Beuill quadrant eleuate her one degree or poynt higher: As if ſhee were formerly at ſixe poynts or degrees, ſhee may now be ſet at 7, and then giuing fire, if it ſtrike the marke, hee may alwayes order it in the ſame manner afterwards. But if it were too high, little, or much, hee muſt accordingly diuide that difference betweene the ſixth and ſeauenth poynt or degrees by diſcretion (by the lighting of the laſt Shot.) And if it were too low, then proceeding in the ſame manner, to adde to the ſixth poynt, with iudgement: and ſo may aſſure himſelfe hee may be like to get reputation thereby. But if he be to order a peece to ſhoote by the leuell of the *Soule*, or Axis of the *Bore* horizontally, then place a peece of boord, within or vpon the bottome of the bore at the muzzle, as in the precedent Chapter betweene the ſaid long Ruler and Beuill Quadrant, raiſing or imbaſing her with Handspeeks and Quoynes, vntill the plumb line of the ſaid

Beuill,



Beuill, hang directly in the midst thereof: So will the Soule or Axis of the Bore lye directly leuell or paralell with the Horizon. Then taking away the Ruler and Beuill, and taking by the highest of the mettall at the breech and muzzle, direction to lay her right, and to what marke they respect for height; note that for after vses, and giuing then fire, he may attaine therein his desire.

Forasmuch as opportunity will not alwayes permit to place the same on the Mouth as aforesaid. The Gunner may keepe that thicknesse or dispart in his hands, and take his leuell by the mettall as the fashon is, vntill thereby he discerne the marke, and them both to bee in one right visuall line. And then setting on the dispart vpon the muzzle ring duly, and bringing downe the mouth of the peece vntill the said marke, and the top of the dispart, and the highest of the mettall at the Breech become all three in one right visuall line: then take off the said dispart, and note what marke will then bee in one right line, with the midst or highest of the mettall at the breech & muzzle, which will be much vnder the first marke, and it will so serue euer after to make a shott, to an assured good effect at the same marke, and with the same peece, from the same plat-forme.

The like is to be done in shooting at a marke, eleuated to any degree about the leuell: As also for such marks as are beyond the distance of the right line or right range, by allowing an addition of a Minute, Degree, or Poynt of eleuation, for aduantage more or lesse, as need shall be, vntill the Shot hit right, and as reason will direct. As for example, a Saker is to shoote at a marke eleuated vnto 15 degrees, it being distant from the plat-forme 1325 Geometricall paces 5 feete to the pace. But being mounted to the second poynt, or 15 degrees, she will shoote but 1062 paces in her dead range, and in her best Randon she will conuay a shott but 600 paces, in a right line, wherefore it being almost 300 paces short of the dead range for 15 degrees, and about 700 paces short of her right range vpon her best Randon, I must by my Gunners Scale, or by the Diagram of Randons in the 27 precedent Chapter, by the perpendicular raised from the Base at 1325 paces, finde what randon crosseth the aspect of the second point, which will be thereby found to be the fifth points Randon. If then I shall mount the said Saker vnto the fifth poynt: so then I may expect her said Randon, to strike or come neere to that marke, that shall be eleuated to the aspect of the second poynt, or 15 degrees, at the distance of 1325 paces, and so after 2 or 3 shotts at that aduantage attaine my desire.

This is the ordinary manner of shooting vpon aduantage of any Moun-  
ture whatsoeuer, alwayes obseruing the meanes how to draw as neere the  
Enemie as can be. In generall, you may obserue, that in taking ayme by the  
highest of the mettall, without consideration of the disparture, if the visuall  
line thereof aspect the marke, the shott will bee alwayes too high within  
the right range, contrary to the Gunners disigne, which should be to rui-  
nate the Foote of the defence in Batteries the sooner to ouerthrow the wall,  
also to facillate the entery of the Breach, but singly to shoote at a Troope of  
Horse or Squadron of Foote, and especially in grauelly or stony places it  
were not amisse purposely to shoote short to light vpon the stones, to beate  
them so vp, as that the rayfing of the grauel and stones may do the more exe-  
cution



cution, entering trauerse-wise amongst the Enemie: But in a plaine or leuell Champion, and amongst Battalions of men the Peece should be so bended and directed, as that her shot may passe by the midst or thickest of them, girdle height: and so it may cut off a hundred, or whole Ranke or File of Men at once, and breake their Orders and Ranks, whereby those that fall on their Faces will hardly escape, but shooting over, profiteth nothing at all, but is meereely lost.

To amend a wide shot, if it went too much towards the right hand, then remoue the dispart, or take the large of your sight line somewhat more towards the left hand at the muzzle ring, keeping the former height, or letting the Dispart stand as before, and take your mark as before, onely remoue your eye a little more towards the right hand vpon the Bale ring: And so likewise doe contrariwise, if the fault of the shot aforesaid went too much towards the left hand: and so you shall assuredly amend the former shooting, vnlesse some of these ouer-ruling causes or accidents cause the contrary, namely her Soule or Concaue bore, not being strait and right, or lying a wry in the body of the mettall, for then the fault is not in the Gunner, but in the Gunne, which hee must with iudgement and good discretion rectifie, as hath bene already shewed in the 44. Chapter hercof. She will shoot wide also if the Trunions lye not directly the one against the other: as also if the plat-forme lye awry one side higher then the other: or if the Gunner take not his ayme, so that the visuall line that passeth from his eye to the marke: or if one wheele be higher then the other, or if one wheele be stiffe and the other iocond, or be squatted with any rub in the reuerse of the Peece, or run vpon soft, and the other vpon hard ground: or if the Cariage-maker hane made the Cariage leane, or hang more vpon one, then the other side: If the Naue be too wide, that the Peece shake therby in her discharge, and reuerse: or if the tayle of the Cariage rest harder on the plat-forme vpon one side more then on the other, when the shot is too lowe for the Peece, and at the deliuey toucheth vpo one side. And lastly the vehemency of the wind being sidewise, ouer-rules it to the contrary-side-ward, &c. But if the Shot fall too short or too farre, that happeneth by the force or feeblenesse of the Powder, or vnskillfulnesse of the Gunner, not directing his peece as he ought, or in ignorance, or by mistaking the distance to the marke he would shoote at.

### CHAP. XLIIII.

*How the Gunner may be assured to make  
a good Shott.*



Sometimes the occasions offer to require, that the Peece be curiously directed, and precisely bended to dismount a Peece of the Enemies that galleth shrewdly, or at a single mark, or at the Loope, Tronier, Cassamar, Horseman, Boar, or other secret place assigned, that else would impeach the appointed seruiue and desaigne: For which the Gunner



ought to haue an entire and perfect knowledge of the condition and quality of his Peece, by experience made by former practises in her, otherwise it will be vncertaine and vnlikely, that he at the first shot, out of a Peece, wherein they neuer practized, to make an assured good short: and then in loading her, to haue great care so to put home the Powder, Shot, and Wadd as that the powder may fire at once, that the Peece reuerse not vntruly, it being a certaine thing, that the more slowe the powder is in firing within the Peece, the greater will her reuerse be, and the short also of the lesse force in execution. And likewise the reasonable putting home of the Shot and Wadds, neither too hard nor too easie, but that the Ball may gently with a conuenient vent, onely enter in close vnto the Powder-wadd. And lastly, hee may direct his Peece by the Quadrant Beuill inch rule, or other former directions, taking his ayme directly by the highest of the Metall vnto the assigned mark, or with a due dispart placed vpon the poynnt of the muzzle ring, which highest parts may there and at the Base ring also, with a small line be noted for the visuall line to passe vertically over them: And then giuing fire, let him not doubt of an assured good effect, hauing a diligent hand in preventing the accidents that are to be provided for, as in the 43 Chapter hereof are mentioned, to auoyd side, ouer, or vnder shooting, and considering well that such a good short made, gaineth the *Gunner* much loue and honour. The fittest Peeces for that purpose, are either the *Culuering*, *Demy Culuering*, and *Saker*, or the *Cannon*, *Demi-Cannon*, and *Minion*.

Such a Shot ought to be made knowne to the *Generall* of the Army, who should therefore liberally reward the *Gunner* that made the same, not onely to encourage him, but others also, afterwards to doe the like, or better, if it were possible. *Louis Collado* in his *Manuall Practise of Artillery*, writeth, that at the Siege of *Sienna* there was a Peece lodged vpon the great Church, from which the besieging Army receiued much damage: but in the end a *Germaine Gunner* made a short thereat, who at the first did not onely dismount the same Peece, but also made the *Gunner* thereof, and those that were about him, flye together in the ayre to their destruction: the which *Marquis de Martinian*, the *Generall* of the Army seeing, it pleased him to take a Chayne of gold from his owne necke, and to giue it vnto the *Gunner* that made the shot, for his reward, which did not only reioyce him, but encouraged all the rest of the *Gunners* to endeouour diligently, so to purchase the like honour and reward, when like occasions were presented.

## CHAP. XLV.

*How to make Ladles and Spunges for euery sort of Ordnance.*



It were very requisite that the *Gunner* himselfe should know how to trace, and cut out, and also make vp, and finish, all manner of Ladles, to loade Ordnance with, either when neede shall require, to prepare them himselfe, or at the least to direct others how they should bee proportioned and wrought,





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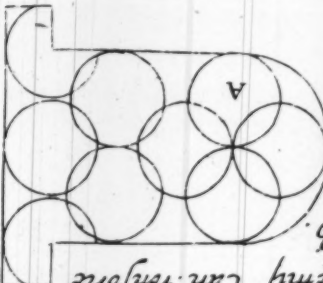
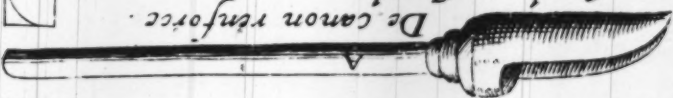
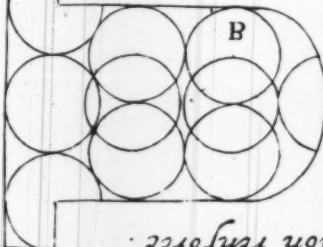
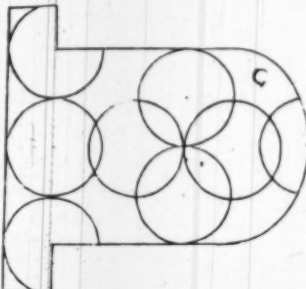
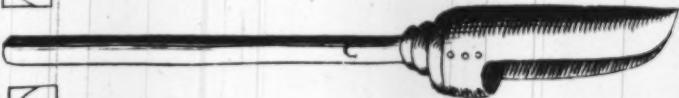
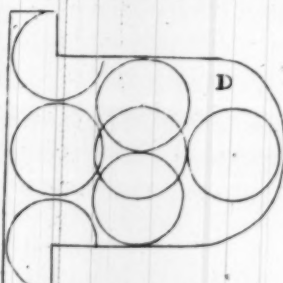
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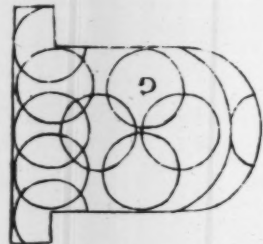
De demy can. renforce

ur halben geserckten Carth.

De commun quart  
zum gemeinen 9.

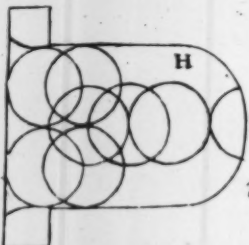
*Du quart amondré.*

Zu verunglückten quart



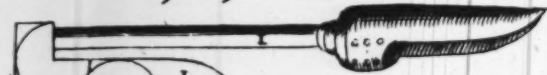
De demy canon commun

Zur halben gem. Carth.



*Deum canon amovendi.*

halbe geschwechte Carth



De piece

enchambre ou campaine.



I

as also, that he may be the better able out of the Magazin or store, to make choyse of such as shall best fit those Peeces that are vnder his Charge and Command: For as it is a dangerous thing, or a great shew of ignorance to mistake one sort of Shot for another, which may soone happen, if he know not how to examine or Calibre them: so it is not onely shamefull, but dangerous also for a Gunner, to employ an improper Ladle, vnlesse vpon necessity, and then also with great care and iudgement, being either too long, too short, too lowe, or too high for the Peece, for being too high, it will not enter, too low, it will not fill, but spill, and too long ouer, and too short vnder-charge, each of which should bee accounted for an absurd fault. Wherefore Ladde every Gunner to be very vigilant and carefull, that hee commit not that error, but rather to be industrious, not only to learne how to make his Ladles and Sponges himselfe, but also to bee able to direct and shew others, how they ought to be severally proportioned, made & distinguished: as followeth.

For double fortified Cannons, to charge them with two Ladle-fulls, they are to be two dyameters and a halfe of their Shot in length from the head of the Ladle-staffe, which shall be one dyamete more of plate, which must goe about the said head. The Brasse plate must be in breadth two dyameters vnder the said head where each side must haue halfe a dyamete more, to enclose the head of the Ladle-staffe within the plate.

The Button or head of the Ladle-staffe must be one dyamete, and of such height or thickeesse, that it together with Brasse plate may bee equall to the height of the Shot (due vent being abated) for Sponges, their buttons or heads are to be made of soft fast wood, as Aspe, Birch, Willow, or such like, and to be one dyamete, and  $\frac{1}{2}$  in length, & not aboue  $\frac{1}{2}$  of a dyamete of the shots height: The rest being couered with rough Sheepes skinne wooll, and all, be nayled thereon with Copper nayles, so that together they may fill the Soule or Cavity of the Peece.

The Button or head of the Rammer, must be turned of hard wood in length 1 dyamete, and  $\frac{1}{2}$  of such height or thickeesse, that it may fitly enter into the Peece the shots vent allowed: it were the better for fashion & strength: if the  $\frac{1}{2}$  next the staffe were handsomly turned with abatement, and a Ferrill, or Circle of Brasse fitted thereupon, to saue the Head from cleauing, when as with force we shall ramme the Shot home. All these Heads or Buttons must be pierced  $\frac{1}{2}$ , with a hole for the staffe an inch or more dyamete, wherinto the staffe must be fastned: and the staffe must euer be so long, that it must be at the least one foote longer then the Cavity or Soule is deepe.

For the ordinary Canon, the Ladle must be of the same bredth, but must not surpasse 2  $\frac{1}{2}$  dyameters of the shot in length: and for the lessened Cannons two dyamete onely to loade at twice, all according to the fashion, length, and breadth, as is shewed in the 20 figure, with the manner of fastning them vpon the staues; wherein also the fashions as well of the Heads or Buttons, as of the Ladles and Rammers, are so represented to the eye, that the discrete Gunner shall neede no other instruction therein: Where the description for the Demy-Cannons, which are of the same measures and proportion as afore-said are these, hauing respect to their owne proper Bores.

The Ladle for Culuerings and Demy-Culuerings, haue foure dyameters of their



their proper Shots in length, and two in breadth.

The Sakers, Faulcons, & Falconets, which may with one Ladle be load at once, may haue their Ladles of 7 diametres, &  $\frac{1}{2}$  diametre of their Shots in length, besides that Couerture of the Head of the staffe: and of breadth 2, as all the rest haue.

For *Periers*, which vsually haue Chambers, with ore loes:  $\frac{1}{2}$  or  $\frac{1}{3}$  lesse in bore, then their Chase containeth, to them 3 times the diametre of their Chamber may be allowed for length of their staffe.

Now if it should chance you were (having no Ladles for Ballance ready) commanded to load a Cannon, or any other Peece in haste: First, put the rammer into the Peece vp to the Touch-hole, and make, the staffe, euen with the mettle at the mouth of the Peece, and then pull it out 3 diametres, for the Cannon, and  $\frac{1}{2}$  for the Culuering, and  $\frac{1}{3}$  for the Saker Falcon, &c. and marke there another marke, which is the place that the Powder must supply in the Chamber: And then take Paper, Parchment, or Cloath, as long as the distance betweene the two markes wrapped round, being of height equall to the bore of the Peece,  $\frac{1}{2}$  lesse, fasten the same with mouth glew, or sow the sides and bottom, and fill the same with powder, and powre it into the Peece, putting it gently home, doe so vntill you see the last made marke, to be equall to the flat of the mouth, the Rammer head being home vnto the Powder, then put in your Wadd and Shott, as else-where is taught.

## CHAP. XLVI.

*How to make Bridges ouer great or small Riuer, to passe  
an Armie with the Ordnance, and other Cariages  
ouer the same.*



Fren times it so happeneth, that passages are stopped, and not to be recovered, especially about Riuer for want of Bridges, or else some Marrish or Moorish place interposeth: Wherefore to bee prepared in all Accidents, especially to passe the Ordnance ouer a Riuer, that one Bridge or Moore may be speedily made, either with Boats placed 12 or 14 foote asunder, and moored by Ankors fast a head and a sterne, especially where the Riuer ebbeth and floweth, else if they be but fast a head, it may serue they must at such distance be layd in a right line, to ride crosse the whole breadth of the Riuer, at the place appointed. And then betweene each two next Boats, place 3 beames of Timber, being 18 foote in length, whereof 14 foot must be to reare betweene the 2 next Boats at each end, two foot must be to beare vpon the Boate, which Boats must be of euen height or nigh, and the Beames are to be layd 6 or 7 foote wide, each from other, that the bridge may be 10 or 12 foote broad, as well to conuay ouer the Horse and Foote



as the Ordnance, Carriages, and all other necessities belonging to the Armie, for the surety and strength of which, there must vpon euery Boate be also three other peeces of Timber of such length, that it may at each end reach 3 foote ouer the Boates side, vnto which the three Beames aforesaid, must be fast pinned with Tree-nayles and yron bolts, with forelockes and keyes, to make them fast one to another. These Beames and Timbers are to be conered ouer with Planks two inches thick, or one inch and a halfe at least, and 17 or 18 foote in length, the description of which may be scene in the 17 figure at *a*.

But if any boggy or muddy space be betweene the Riuer and the fixed ground, so that the Ordnance cannot be brought nor drawne neere enough vnto the Bridge, then that part must be filled vp with such things as are fittest to make it firme, whether it be with Faggots and Earth, or Chalke or stones, pyling the sides with Timber driven in, vntill they reach into firme ground at the bottome for foundation, and to reuest it then with boords or walls, according to the time intended, it shall last and continue, that thereby the way may be firme land and euen. But if any doubt be that the Enemy will surprise this Bridge, to make himselfe Master of the Riuer then at each end thereof, a halfe Moone, or Reddout, or Fort, with Ordnance to doe murther, and fire-works must be prepared to preuent him, and therein besides the side of the Bridge, may bee palissadoed with long strong sharpe poynted sparrs fastned, thereto to secure it that way. Also a continuall and a carefull eye must be cast vpon euery part of the Bridge, that if any accident of defect be in any place, it may be speedily repayred and amended: and a Rayle on ech side would be needfull for a stay. A Bridge also may in like manner be made with Trunks, as is represented in the said Figure at *b*. And also to be linkt vpon one great vessell, with a falling defensue poynted pallisado, as therein likewise at *c*, is represented, and vpon Cask, Cables, &c. which I omit, being rather proper vnderstandings for the *Enginier*.

## CHAP. XLVII.

*How to defend a Fortresse besieged, and the order, and what provisions of Amunition will be necessary for the defence thereof.*



Fortresse besieged being well defended, may returne to enioy her former liberties, which the better to doe, it will be necessary to make plaine, cut downe, and ruine whatsoeuer shall be hiding and hurtfull, within halfe a mile or more round about the Fort, be they Bankes, hollow wayes, Hedges and Dykes, of Lanes, Bushes, Trees, Houses, Mills, Gardens, Conduits, and such like obstacles, as not onely hide them, but hurt you also.

Next looke that the Place bee well victualed, according to the number, for man and beast, fitting for defence, and necessary vse thereof fixe moneths, which

which is the longest time a Fort can be like to hold out, without succour or supply from abroad. Also Amunition must not be wanting, at least so much as may furnish the Flankers and Artillery, which must be as safe and covertly placed as may be, and not to be easily choaked or dismounted. For Amunitions, precise proportions cannot be prescribed, because each day minisheth new necessities, and as the Enemy abroad raiseth or maketh new workes. Within Men and Munition may be reasonably paralleled with  $\frac{1}{2}$  of the besiegers. Then to looke that the Counterscarp (which is the shield of the Fortresse) be duly flanked, covert, and capable, that the false Ports and wayes for Sallyes, be safe, close, lowe, and commodious for issue. That the the Parrapets be of Turffe, or vnburned Bricke, that the platformes for the Ordnance be euen, and the Planks close ioyned, that their Reverses cause not errours, and be also capable for the Gunners and Labourers to trauesse their Ordnance euery needfull way vpon them. The number of your Garison may also be estimated by the quantiries of the places, to be defended by the out-workes you would hold, by the intrenchments imagined requisite, and Sallyes you purpose to make. Now after the proportion of a Place whereas 60 Peeces will be requisite, 12 of them may be Cannon, to beate downe, and batter the Defences and Trenches of the Enemies, and to make therewith Counter-Batteries, to dismount the Enemies Ordnance; And 8 of them may be Demy Culuerings, & 10 Demy Cannons, they being lighter, are more easie to mannage, and 10 Sakers, to keepe the Enemy continually play to hinder their works, offend their Centinells, beat the entrances of the Trenches, impeach their Approaches, and for that they are light, they may be remoued easily and quickly from one place to another, yea out of the Ports with some Drakes, to rake the Enemies trenches, from some part of the Falsebray. And lastly, 20 Falcons and Falconets for Field Peeces, are necessary, and may be able to serue, not onely vpon the Ramparts and Walls, but also at the entries of a Breach, and at single Marks, Horse, man, or Boat.

#### CHAP. XLVIII.

*To make a Counter-battery vpon a Bulwarke, from whence without danger of discovering or dismounting the Enemies Ordnance, abroad may be dismounted.*



Vch Counter-batteries are not to bee made without great labour and charges, neither can euery Bulwarke yeeld a sufficient roome for that purpose, without demolishment of some buildings and houses about the same (which in a time of neede, must not be stood vpon) as in the 10 Figure at *b* the whole structure thereof is represented. All the place must then be of that capacity, that from the Parrapet to the foote of the sholder ther





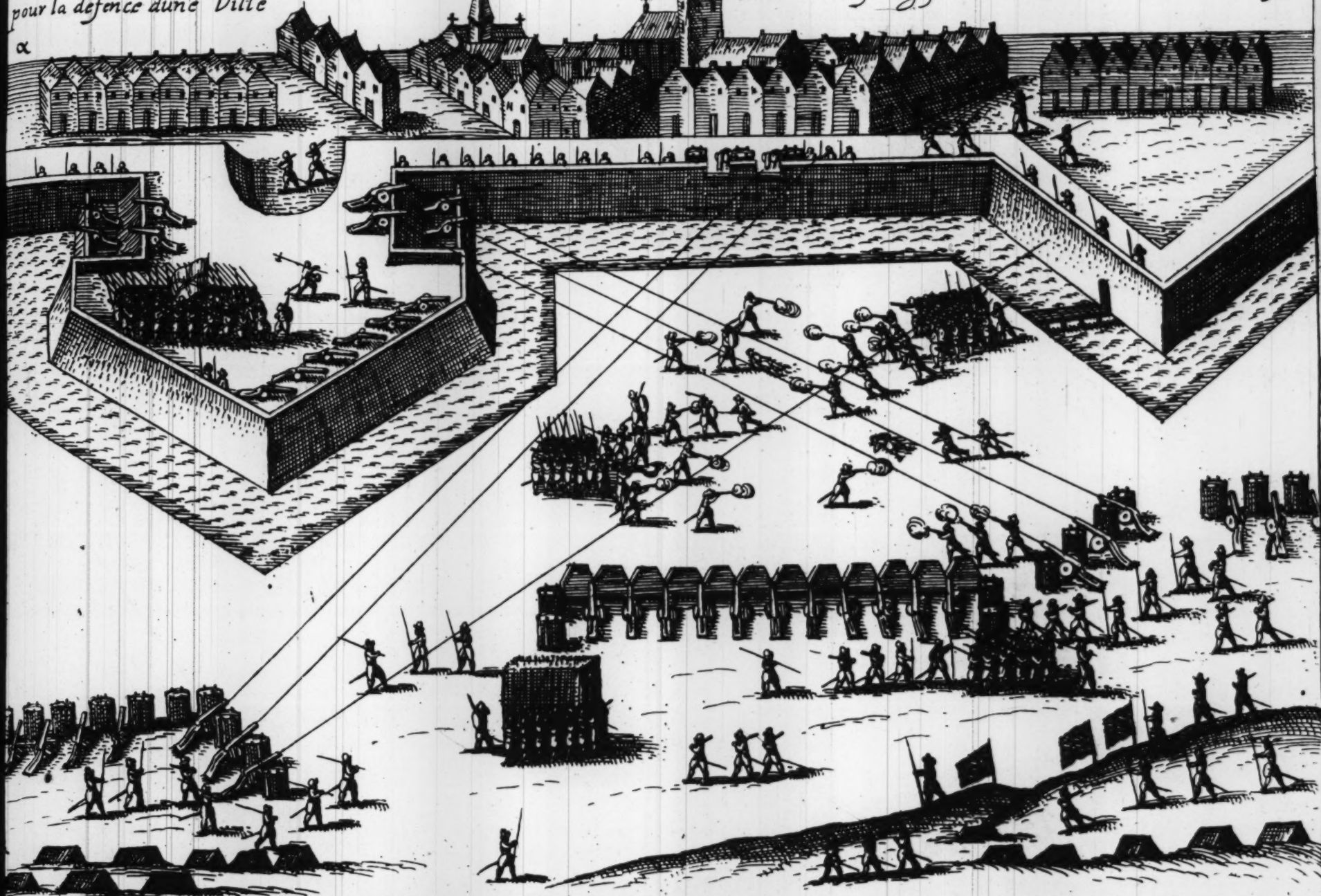


Comment il faut ordonner l'artillerie  
pour la defence d'une Ville

Wie das geschutz zur Defension  
einer Statt soll gestellet Werden.

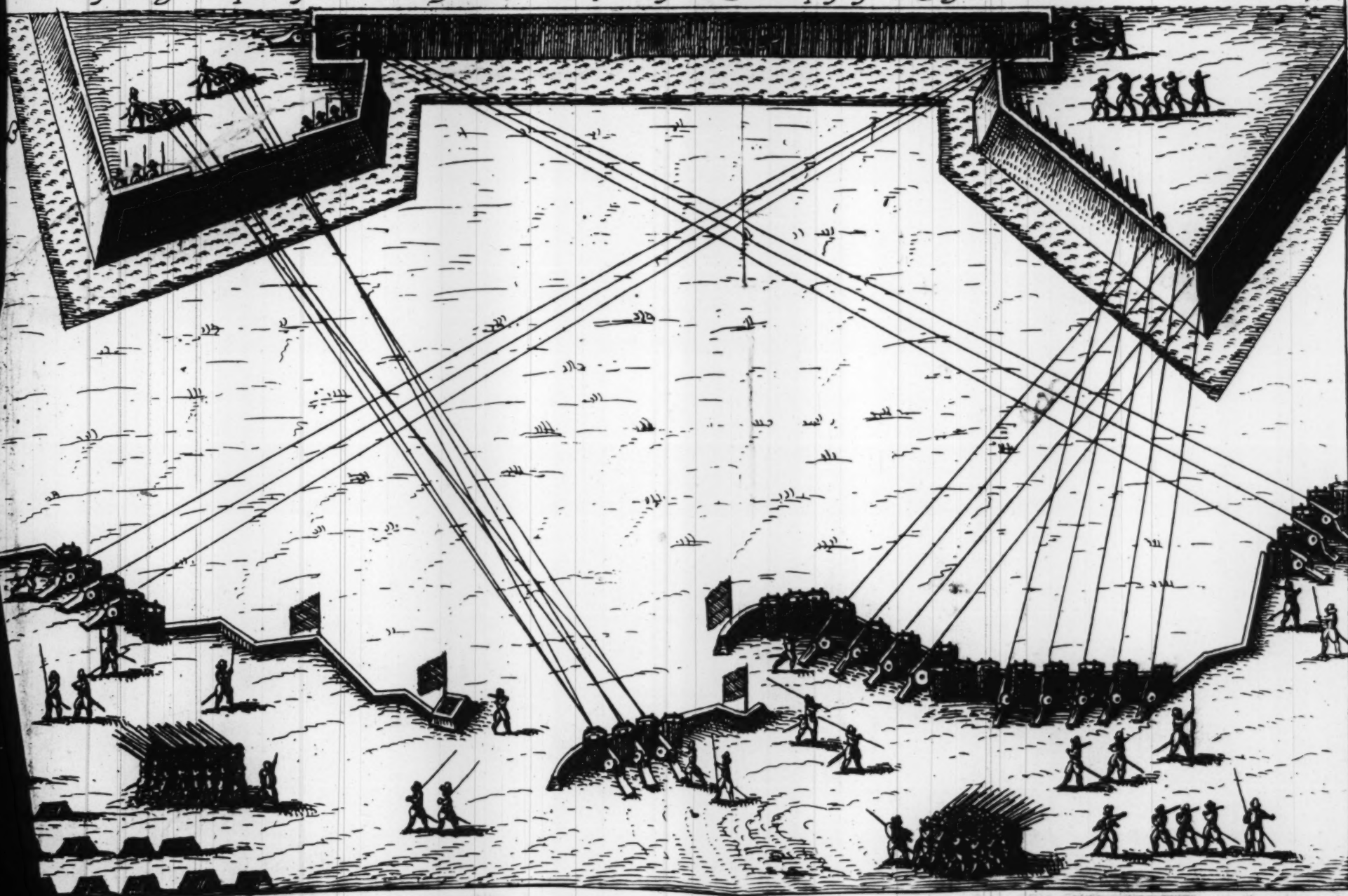
Tract. 2. Dial. II.

30



Comment il faut loger des pieces secretes en un bastion. Wie heimliche stuck in einer pasteyen zu gebrauchen

Tract. 2. Dial. 17.

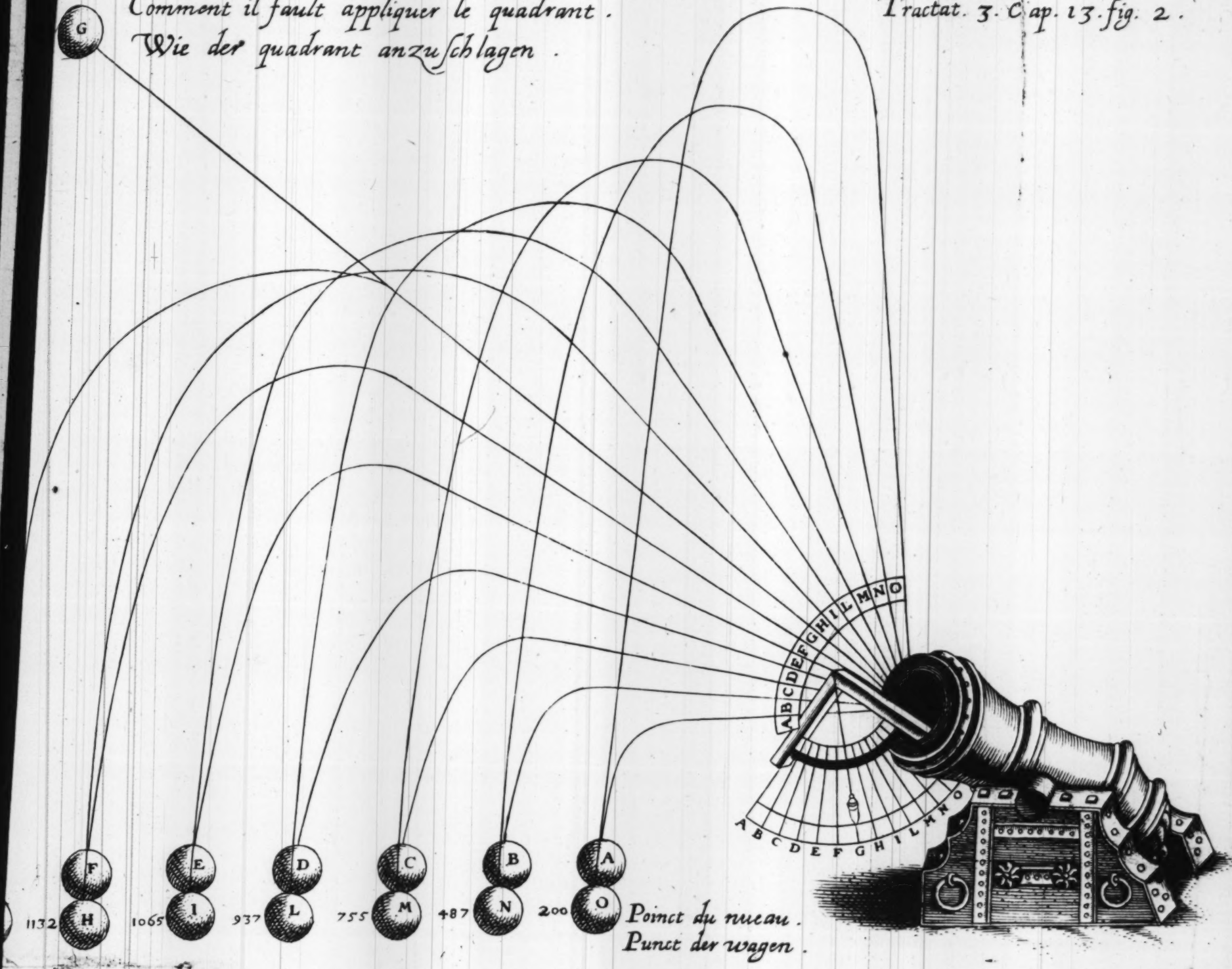




G

Comment il fault appliquer le quadrant .  
Wie der quadrant anzuschlagen .

Tractat. 3. Cap. 13. fig. 2.







there may be foote of ground; and for the thickesse thereof it must be 17 or 22 foote; with 27 or 30 foote for reuerse; for each Peece making almost 100 foote in all, and leauing yet thirty foote more at least from the said reuerse to the other Parapet of the same Bulwarke, to the end there may be no impeachment, but that the Troopes may march and passe to the defences required freely. And hauing also roome to plant three Peeces of Ordnance vpon each of the Shoulders of the same, which will also require 65 foote of ground at the least: The Trunions or Loopes are to be 3 foote broad within, and distant 20 foote one from another: Hauing within the Platformes 3 foote of Barb, and without 5 foote of breadth, and euery where 8 foote of height. These three loopes must haue a counter loope at the Parapet of the Bulwarke, hauing in the midst 4 within 6, and without 8 foote in breadth and deepe, that is be euen with the Terraplane. Now from these Loopes there must be, as we haue said so much toothe, that within the Shouldrings there may be 3 Peeces distant 20 foote asunder. Now two or three of these Shouldrings discharge their three Peeces, trauerfing crossewise to the Enemies Batteries, beating so vpon them, that they must be forced to quit the place: And although the Enemy abroad may beate the Conduits of the outmost Loopes, yet can they neither for the inner Loopes, nor the Peeces within, come to touch any of them: But you may note that such Batteries cannot be made in a narrow or straight place, as I haue said without demolishing structures, and raising the ground so, that it be leuell with the Terraplane of the Bulwarke, which would otherwise be too small for that purpose. And hauing finished them, they are not to serue for one place onely, but they may turne those Shouldrings and defences, and make the Peeces thunder about on all sides where the Enemy would settle himselfe.

CHAP. XLIX.

*Of certaine reasons that causeth a Shott, though well directed  
to erre in her discharge, and be faulty at the Mark  
Wide, short, or ouer.*

Here are very many causes and accidents that may make a Shott well directed, to deuiate from the expected course. The first is, when as the Soule or bore of the Peece lyeth awry in the Body or Mettall thereof, or that the Chase or vacant Cillinder (the director of the Shott) is not strait; wherefore the Gunner may receive disgrace, but hauing examined and found the fault, hee is to supply the defect by discretion and skill.

And if the Trunions also be not duly placed directly in a dyagonall lync with the Axis of the Peece, it will be wide: likewise if the Platforme be vnequall, as higher vpon one side then the other. Also if the Gunner lay the highest of the mettall at mouth and Breech, it will shoot ouer if it be within distance:



distance: if one wheele be higher then another, also if one wheele goe stiffer then the other, or if one wheele meete with a squat by a stone, or otherwise when the Naues be one longer & wyder then the other, when one wheele reuerfing goeth on soft ground, the other on harder, when the Cariage or Trunion eares are higher & lower one then another: if the Cariage be too wyde, so that the Peece lyeth not fast therein, but starteth in her discharge: if the Shot be not equally round, or the bore of the Peece not lying strait, but more on the one side of the metall then the other. The vehemencie of the winde, with, against, or aside, may driue the Shot forward, backe it, or deuie-at it, aside, the thicknesse and thinnesse of the ayre, the heating and cooling, the sleight or hard ramming of the Powder, putting home or short the shott. And lastly, the want of skill and experience: All these, and many more, may be causes of the fayling of a Shott at an assigned Marke, which I thought fit here to note at last, not to minister matter of excuse to ignorant, negligent, carelesse Gunners, but to aduise the discrete Gunner to haue a vigilant eye, and consideration of all, or as many of those accidents with reason, & of the former directions, to auoyd or amend them as wel as he can at first. To faile at the first shott, if he be not acquainted with the Peece and Marke is passable, and at the second to fayle is pardonable, but to faile of a faire shott at the third time, is too much, and argues but little iudgement and discretion in such a Gunner.

#### CHAP. L.

*How to conduct a Mine vnder ground, to blow vp a place, and to prepare a Gallerie, to passe the Dyke to the foote of the Breach.*

**T**He vse of Mining is ancient, and was commonly vsed by the Persian, Greeke, Parthian, Romanes, and other Nations, that haue mannaged great warres, and no meruaile, for that the same is the easiest, and most proper meanes to force a place: But *Pietro Navarro* a Spaniard, was the first that inuented the Fournie and the vse of Powder therein, for which and some other seruices the Emperour *Charles* the fifth, gaue him the name of a *Conde*, and great rewards besides. Yet neuerthelesse, there is nothing more dangerous for such as worke in these Mines, by reason the Counter-mines of the Enemie: so that if there be any suspicion of countermining, it will not be amisse to diuert the course with all dexterity, either toward the right or left hand, as the occasion of the Place will permit. And forasmuch as according to the naturall effects of feare, it behoueth the besieged to seeke out the shortest and neereft way possible, to offend the Enemie abroad by Countermine or otherwise. The Mine-Master then may sinke his Mine, and conduct the same either as in the 16 Figure at *a*, is described by the letters from *A* by *B* to *C*, or as the other 4 square angular course, and there to prepare the Fournie, which may be armed with powder in Barrels, so that giuing Fire thereunto by a Trayne, he

blow



blow vp the Place and the Enemies about it : And to the end the same hurt not the Pyoners or Worke-men that digge and trauell therein : It will bee needfull to lyne the same with sparres and bords framed accordingly, seauen foote in height, and 5 foote in breadth, but it must be couered with 2 inch planke, to keepe vp the earth : But if the ground be moyst or full of Springs, a gutter with a descent must bee made, that the water may runne to some lower euacuation ; if that cannot be, a Well at the mouth of the Mine must be made for a receptacle for all the Springs to runne into by their gutters, and Pumps or Forcers, are to be set sufficient to mount the water, that it may after finde a current to runne away. But if there be any suspicion of Counter-mining ; then alwayes forwards in your intended course, you may bore long holes in the earth with your long ground Awgars vsed for such purposes, and pierce holes on all sides, also to know vpon what part from you the Enemy worketh, which cannot be done so priuate, but so the noyse of their Mattocks and Shouels will soon be heard by those pierced holes, when you come neere their workes : if by those meanes you heare nothing by reason that the besieged had ended their Countermines before you began, and he watching them heareth you worke, those piercers being but 12 or 15 foote long, will discouer the danger by boring thorough the solid earth, to the hollownesse of their Countermine ; and so you shall haue Counter-advantage of the Enemies counter-minings. My Cosmodelite before represented, is an excellent instrument, and for that purpose I thinke the best extant.

Now being come right vnder the place to bee blowne vp, and made the Fournie arched vpwards higher then the Mine place, therein sufficient powder, either in Barrell or Troughes, you must also stop closely and strongly the mouth of the Fournie, very diligently, looking it be so close that no ayre breath out, but at one small hole wherein the Trayne runneth in to giue fire thereunto ; vnto which he that giueth fire, must looke that the Match of the Trayne, bee not too long before the powder take, as also to see it bee not too short, and so to giue fire too soone, that is, before he be gotten into some place of safety out of the blast and ruines, least hee pay the wages of improvidence. The meanes then to set the matter a worke, needes no long discourse, being very commonly knowne, onely to aduise that the enterance into the Mine for height and breadth as aforesaid, may be as close and secret from the Enemy as may be, and that in his proceeding on, he must diminish those measures in such manner, that in the midst it be but 5 foote high, and 4 foote broad : And the neerer you come to the end, so much the lesse giue in breadth, so that euen to the coming in to the Furne it must be close and narrow, that you may onely get the powder thereinto.

About all things, the Mine-Master before he begin, must be sure to know the true measure and distance, with the height or depth of the place intended to bee Mined, bee it about or vnder the leuell of the place hee beginneth, most precisely taking exact notice of all his windings, turning, and angles, which he maketh from the beginning to the end, as well about and vnder the leuell of the right line, passing thence right vnder the Place, as towards the right and left side thereof : Otherwise his labour will not onely be deficient, but also vncertaine and most dangerous : there being foure principall



causes to impeach the effectuall working thereof. First, the ill stopping of the Fournie : Secondly, the weakenesse of the sides by countermines or Cavernes. Thirdly, by failing of the Frayne by moisture or ill contriving. And fourthly, the most important, is, that the Frame whereupon the Barrels stand, be not placed too low, as vnder the leuell of the enterance, which it must ever exceede, because the quality of fire is alwayes to ascend. And so observing every 15 or 20 paces, how high, or lowe, or wide on any side you are gone, about or vnder the leuel strait line. Two of the greatest shames to Souldiers, being either to lose any peece of Ordnance, by negligence or ill guarding them : Or the fayling of a Mines due effect.

And for making great or small Galleries to passe a dyke vnto a Breach couertly, be the dyke watered or dry, the maner is described in the precedent Figure with the Myne, and may be made ready in seuerall parts, to be set together speedily by ioynts, fitted for that purpose, for the easier cariage also. And they must be covered over with Faggots, earth, & greene Hides to prevent firing them.

### CHAP. LI.

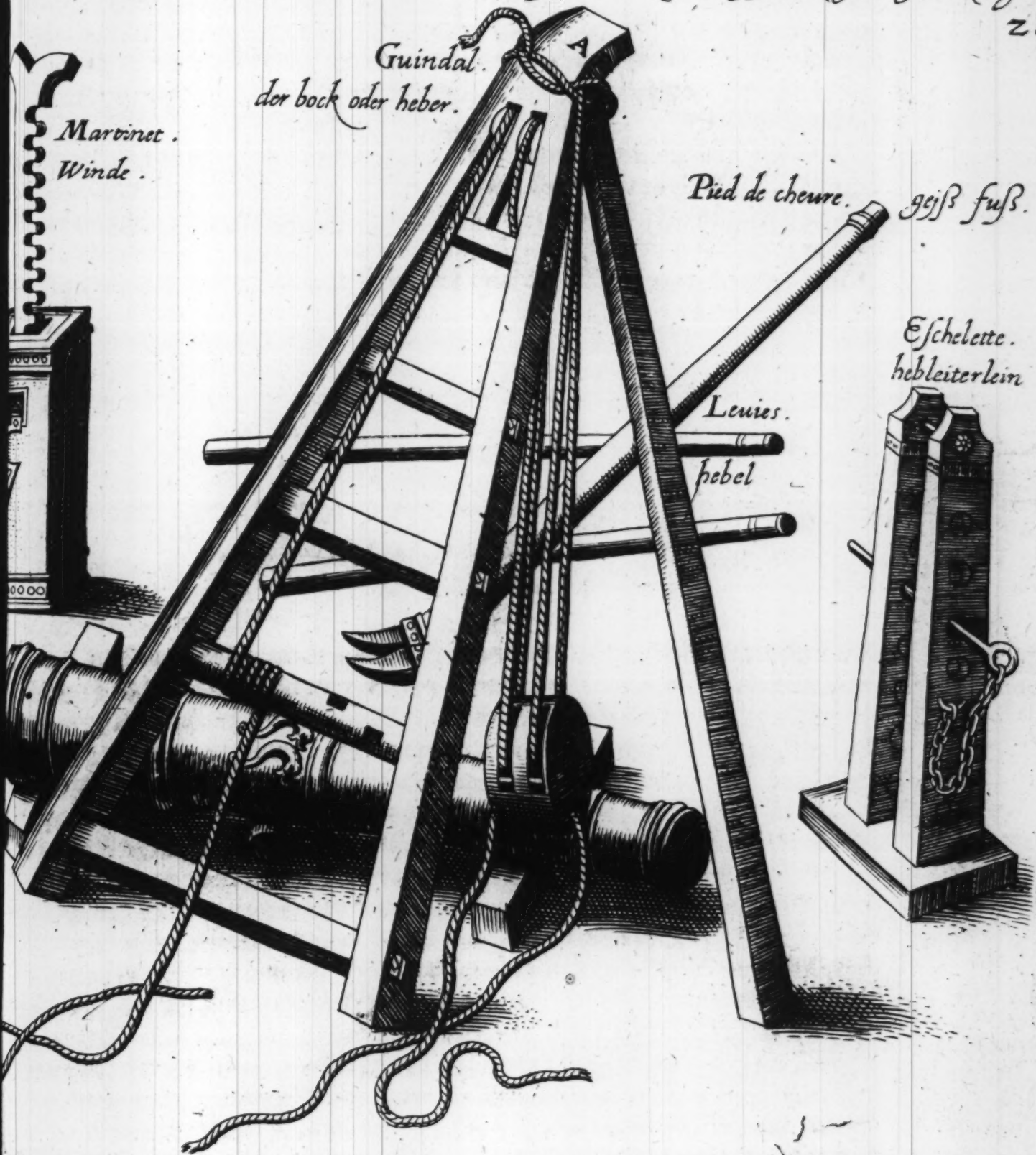
*Of the Guindall, Windlas, and Ginne; or Martinet, Krow, and Handspyke, and Leuer, and the endlesse Screw.*



**T**He Guindall or Windlas, is a convenient ingenious inuention, to mount a peece of Ordnance, or heave aloft waighty matters, and is represented in the 24 Figure, with the Crow of Iron, or Goates-footed Handspyke, and Leauers, accompanied with the Ginne or Martinet, which will lift vp the Axes, when the Peece is vpon her Cariage mounted, to take off, or put on the Wheelles, to grease, or ease, or mend what is amisse about them. The Guindall is thus made of a peece of Tymber, fixe inches square in the fecte, or with three young dry Oken Sparres, about 12 or 15 foote long, ioyned together at the top with an yron bolt, passing through Iron Ferrills, vpon which bolt a double pulley is hanged, and at the lower end of each Sparre another yron Ferrill, and a Pyke of yron is placed to keepe the fecte from all slipping, almost at the lower end of two of those legges or Sparres, a peece of a Sparre about 4 or 5 foote long, is fastned betweene them, and also 3 foote from the end, a Rowle and Windlas, with halfe round yrons, are clasped to those 2 legges or sparres, and about that 2 or 3 other peeces of sparres : In that Rowle, are 4 mortis holes, for Handspykes, pierced thorough, whereby they with 2 or 4 Handspykes turne that Rowle which hath an end of a rope 4 or 5 times, or more about it, and the other end reeved in the said Pulley, so continued vnto another double pulley, with a hole or hooke to take hold, or seize a Rope that hath slung the Peece, appointed to be mounted into her Cariage : Or else the Frame may be

Instruments pour le service des pieces. Tract. 3. cap 8. Der zu dem geschütz gehörig hebreug.

24



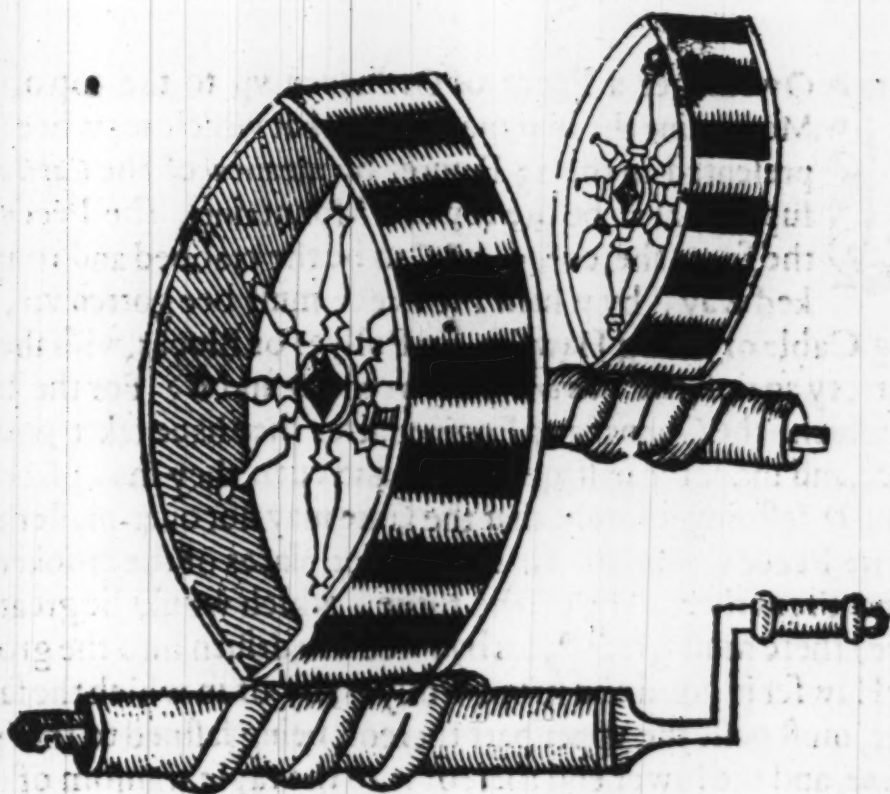


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be of 3 square Tymbers, the head of two of them ioyning at the top together, and the rest for the other legge and parts, may by the sight of the said 24 Figure, be framed and vnderstood sufficiently.



The Ginne or Martinet is another instrument, seruing to lift vp the Peece with her Cariage, and all her furniture from the ground with one mans strength, when the Gunner would change a bad wheele, or the like, or put a wheele on vpon the Axiltree, or take it off for any purpose, the proportion of this Engin for the vse of Ordnance, is that it ought to be about 2 foote long, and 8 inches square, or thereabouts: the Viceron is of yron forked, to take hold, and with his teeth is wound vp by a handle, with a spurte of fewe teeth, it will lift a great waight, multiplying the force proportionally, according to the height of the secret wheele, and of the said spurte (contained in the distance of the handle, from the centre of the spurte) or to semidiameter of the handles circular reuolution, dyamettrally multiplied by the reasons betweene the spurte and wheele. That Viceron commeth out of the midst of the said square case of wood, at the top thereof, and by his Fork or Esse, taketh hold of whatsoeuer is fitted to bee lifted vp. The Scaletta with the rest may be easily made, vnderstoode, and vsed, as in the said 24 Figure is described. And for the same or any the like purpose, the *endlesse Serie of Archmedes* here aboue represented, is of infinite effect being duly applied.

## CHAP. LII.

*How to draw a Peece of Ordnance vp to the top of a steepe  
and rough hill or mountaine.*



Now to get a Peece of Ordnance vp to the top of a steepe Mountaine the best manner is, that which may bee scene represented in the 23 Figure, by meanes of the *Capstane*: As suppose *D* to be the top of a Mountaine, the Peece being at the foote thereof, *A B C* to be the crabbed and rough crooked way, by which the Peece must bee gotten vp, drawne with a long Cable or strong Hawser, by Pulleyes or Blocks, with sheeuers to make a Battery against the *Tower F*, betweene *D* and *C*: For the better effecting of which, the Gunner and Engineer after they haue taken good notice of the Place, and made the passage smooth and euen, they may place the *Capstane* behind *D*, fastning it surely, that the same may not ouer-master the great poyze of the Peece: And then in conuenient places of the crooked way (if there be no Trees there to serue the turne, which would be great helpes if there were) there must great Pyles by force bee driuen into the ground, to fasten the Hawser in good and strong Pulleyes, by or in which the said Cable or Hawser, must passe the vpper part thereof, being fastned to the spindle of the *Capstane*, and the lower end thereof vnto the tayle transom of the Carriage or Rings neere the same, at each side one. Lastly, foure or more men turning the *Capstane* about, with the Barres thereof, shall first make the Peece to mount vp vnto the first Pulley or Block at *A*, where it must be first scotched, vntill the Blocke be taken away, by taking out the Pinne or Axis of the sheeuer, and then the Peece is to be tauersed towards the second Block or Pulley *B*, and so to the third *C*, and then to the desired place neere *D*. It were also needfull to haue a small Truck, as well to beare the Tayle vp from staying against rough stubs or stones in the way, as also to helpe the motion, Labourers also must be readily attending neere vnto the Peece, as well to aduance and helpe the Motion, by heauing and shouing the same, as to tranerse the Peece the rightest and best way, as occasion shal require, as in the said 23 Figure may bee scene. And after each Pulley, hath performed his office, let a man be ready there with greace, vineger or Lye, to annoynt the end of the Axtree, that it may soke into the Naue, least the waight of the Peece in that Motion fire, and also to haue an eye to each of the Pulleyes, that the Cable breake not. And if any danger of its breaking be perceiued, then to giue warning to them aboue to stay, and to them alow to scotch, vntill the Cable be changed or amended. But if the hill be so rough and steepe, that the meanes aforesaid will not doe it. Then take the Peece out of her Carriage, and either lay it vpon a blocke Carriage, or on a Sled with Trucks, and lay planks along in her way where it is rough, and vse then the *Capstane* and Pulleyes as aforesaid. You may also vse for the same purpose *Archimedes* endlesse Scrue, represented in the 51 Chapter.



Comment on peult mener vne piece d'artillerie sur vne montaigne .  
Wie ein Stuck auff einem berg zu zihen .

23





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CHAP. LIII.

*How the Traine of Artillery and Ordnance should be ordered  
with their Cariages in a iourney, or vpon  
a March.*

**T**He whole Trayne of Artillery, one body deuided into two parts *Van* and *Rier*, is wholly vnder the command of the Master, or General of the Ordnance, or in his absence vnder his Lieutenant or Braue, imagine then that the Army be with suspicion according to aduise, to be set vpon by the way, both in the *Van* and the *Riere*. Then were it fit 500 Horse deuided into two Troopes, should aduance, to discover all the Coast of the Champion, with the dangerous wayes, Woods, Thickets, and such like, by which the Army must passe, after these 2000 Foote, should march as well for Couerture as guard of the Ordnance. And they also to be deuided into two squadrons, furnished with all necessaries of defense. After them the Trayne of Artillery, with the Ordnance, marching with their Conductors, Waggones, and Cariages of Powder, Shot, and Tanpions, or Wadding, Coynes, and Beds, together with a reasonable number of Pyoners, and some Marriners, and such like spare people, to bee ready to make Couerts and defences for the Ordnance and Gunners, or to cut wood, to plaine the wayes for the *Van* to passe with foure field Peeeces, ready mounted in their Cariages, with all their necessaries, as Ladles, Spunges, Rammers, Crowes, Leauers, Ropes, Tables, and breechings, with experienced Gunners, Gentlemen of the Ordnance, Matrosses, and Conductors. After follow the Munition and *Engins*, seruing for the vse and defence of the *Rier* of Artillery, with the Boats and Bridges, and then againe follow 8000 Foote, and after them the great Ordnance, either in the Cariages with fore-Cariages, or else vpon block Cariages, whose wheelles being higher, makes the draught the easier. And lastly, follow 3 or 4 Field Peeeces ready mounted, accompanied with all their necessaries and apurtenances of Powder, Shot, Instruments, and Attendants. After which there march 2000 foote more, that are for Couerture and defence of the Ordnance and *Riere* of the Trayne: these are followed with 500 Horse to close vp the Army, whose Charge, is, to see that the *Rier* of the Trayne bee not set vpon at vnawares, suddainly, or vnprovided. The Army then Marching in this Order, The Enemie shall finde the *Van* and *Riere*, and also the Body furnished with force in all places. And being alwayes so provided with the Trayne of Artillery diuided into 2 parts, yet remaining one Body: so furnished, as that no doubt, but a good and a happy issue wil succede such good equipage, well guarded with Horse and Foote, provided for defence of the Artillery, to march without danger, but in large capable Champions. This Trayne may bee shortened, the *Van* taking the right hand, and the *Rier* the left, and the Trayne betweene both, equall in Front with *Van* and *Rier*, and so Marching more compact, it will be the stronger: as in the 6 Figure at \*, by the letters *ABC* is represented to the eye.

CHAP.



## CHAP. LIIII.

*How to draw Ordnance if Cattell be wanting, by the strength of Pyoners or Labourers.*



Artillery or Ordnance, being the principall instrument of the Warres, requireth a great strength of Cattell, either of Horse or Oxen, to transport them from place to place, which being wanting, must in a iourney bee supplied by Pyoners and Labourers: as imagine that 16 Peeces were to bee employed against a Place to bee forced, consideration must be had (Cattell being wanting) how those Peeces, whereof 6 are Demy-Cannons, 4 are Demy-Culuerings, and 6 are Field Peeces, that shoote 6 *l.* ball, and how all the provision that belongeth vnto them, as Powder, Shott, Waddings, and Cordage, &c. may be transported thither, the Place to be forced being situate in a rough, stonie, and hilly ground, by Pyoners and Labourers onely, sparing the Souldiers for other seruices. The Ammunition and Persons that must carie them readily, are first to bee considered of: As 600 Shott for the Demy-Cannon at 30 *l.* each Shott, will be 18000 *l.* loaded in Wheelebarrowes 2 Shott, in a Barrowe which will be 60 *l.* for a Man, and will require 300 Men to drue them. Also 600 Demy-Culuering Shot of 10 *l.* loading 8 Shott in a Barrow, will require 75 Men, each man carrying 80 *l.* And 900 Shot for the 6 Field Peeces of 6 *l.* each Shott, putting 13 Shott in a Barrow, will bee caried by 69 Men, each man carying 78 *l.* except 3 of those men, which shall carie 14 Shott a peece, that is, 84 *l.* each of them: So all the Shot will be caried by 444 Men. The strongest men which carie most, are loaded with the waight of lesse then a bushell and a halfe of Wheat for each man in a Wheelebarrow, which hee may easily drue. Then for the Demy-Cannon, loading them with 18 *l.* of powder for each Shott, will for the 600 Shott amount to 10800 *l.* euery man carying 80 *l.* in a bagge, will require 135 men.

And for the 600 Demy-Culuering, allowing each Shott 8 *l.* of powder, will come to 4800 *l.* each man carying 80 *l.* 60 men will transport the same.

And for the 900 Shot, for the 6 Field Peeces, allowing 5 *l.* for each Shott in powder, that will amount vnto 4500 *l.* which at 60 *l.* for each man to carie, will require 56 men, & a Boy to carie the odde 20 *l.* of powder ouerplus, which will amount almost vnto 180 barrells of powder, each barrell containing 112 *l.* nere.

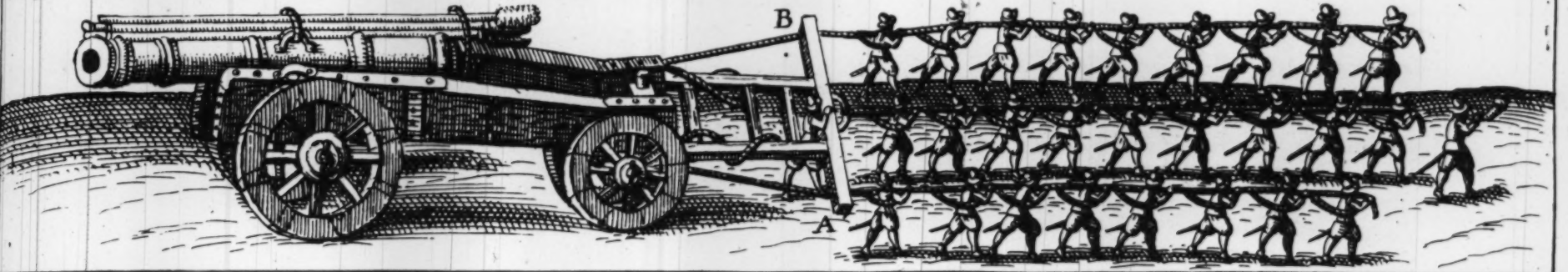
And for the Furniture of the Peeces, the Figure 5<sup>a</sup>, sheweth the manner of drawing them by 3 lines or traces equally devided, according to the number of men that are to draw them, so that the Demy-Cannon with her Carriage, waighing 6000 *l.* reckoning 60 *l.* for euery man to draw, it will then require 100 men, and so the fixe, fixe hundred men.

The





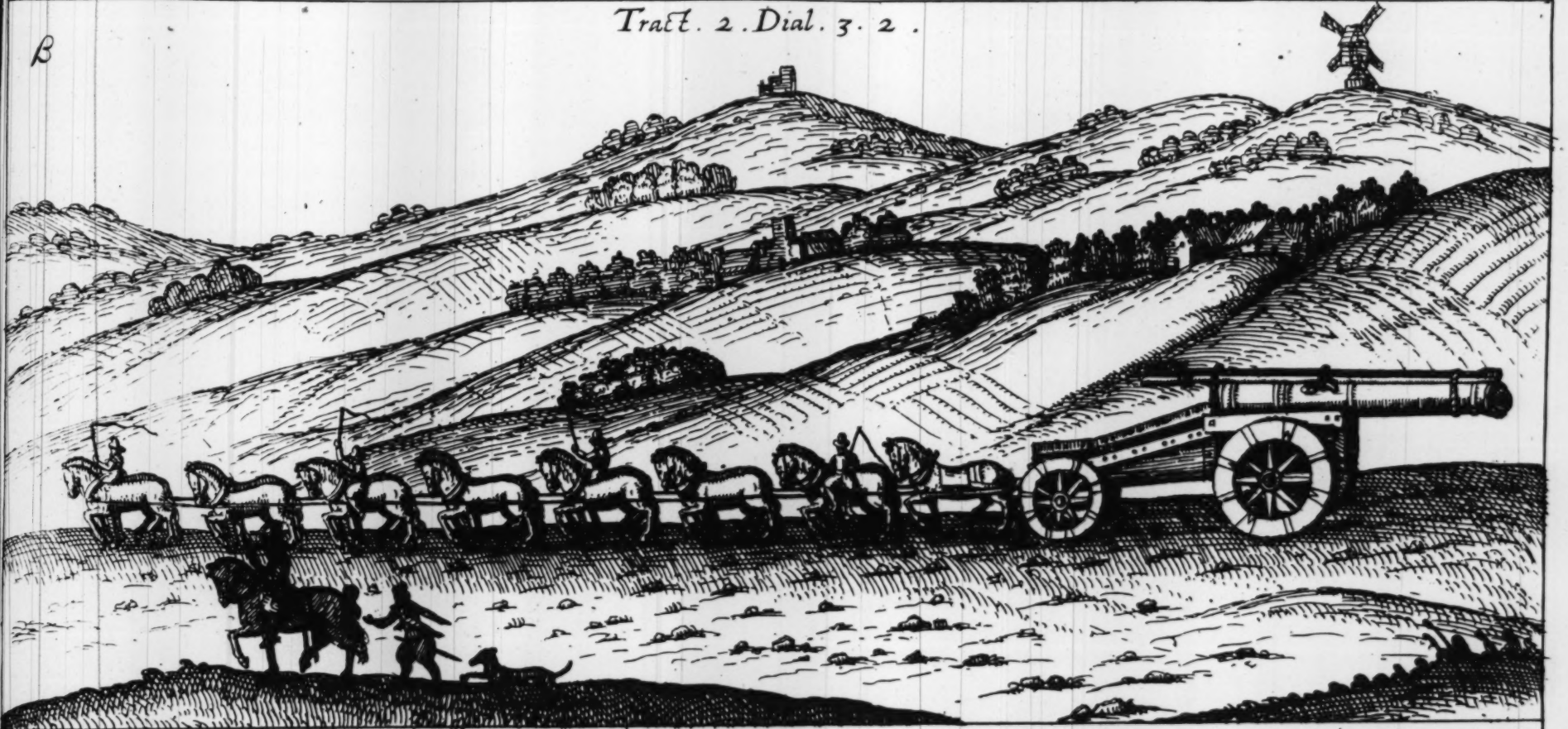
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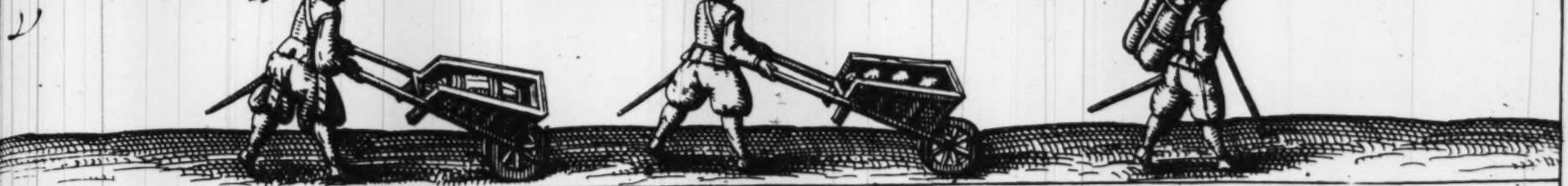
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Tract. 2. Dial. 3. 2.



Comment il fault pour faulte de cheualx conduire tout les munitions que l'artillerie.

Wie in mangel der pfer de beides munition vndt geschutz vort zu bringen.

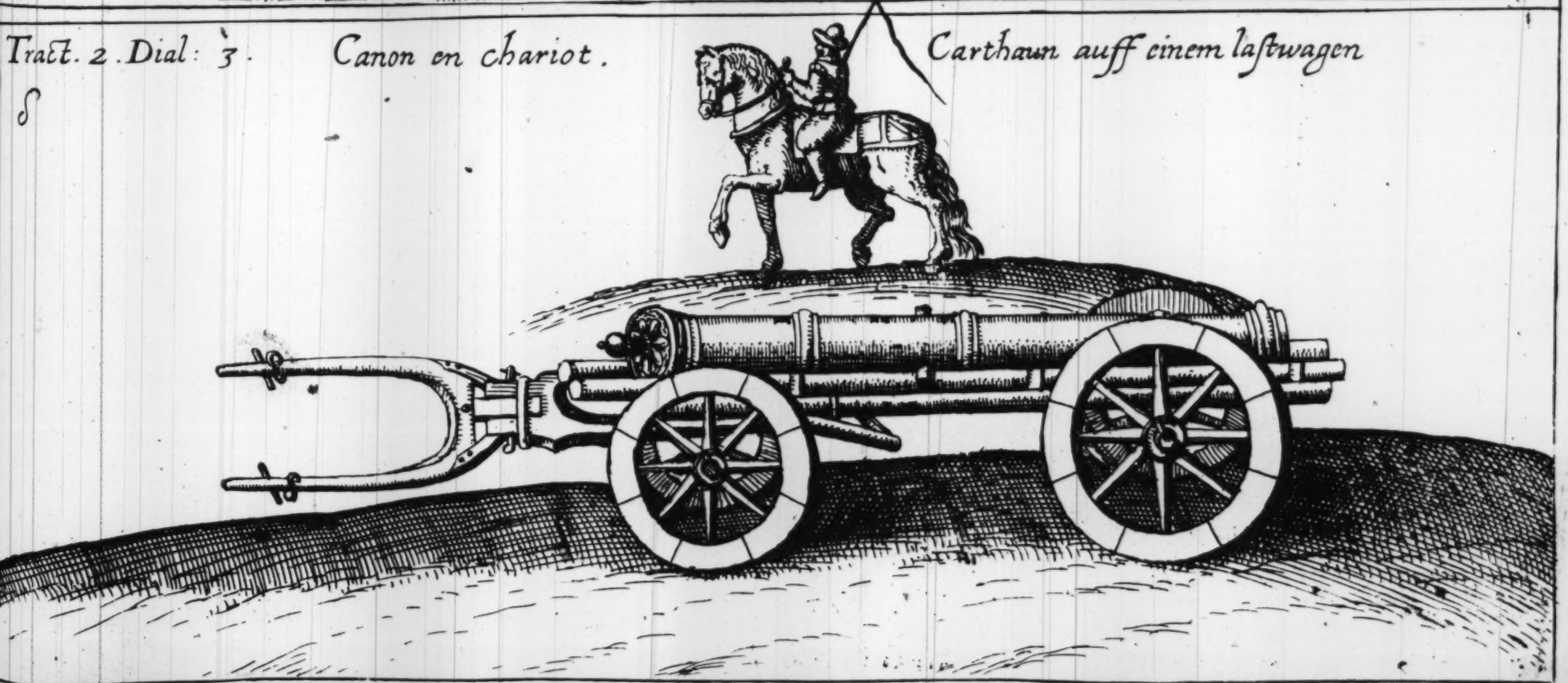


Tract. 2. Dial: 3.

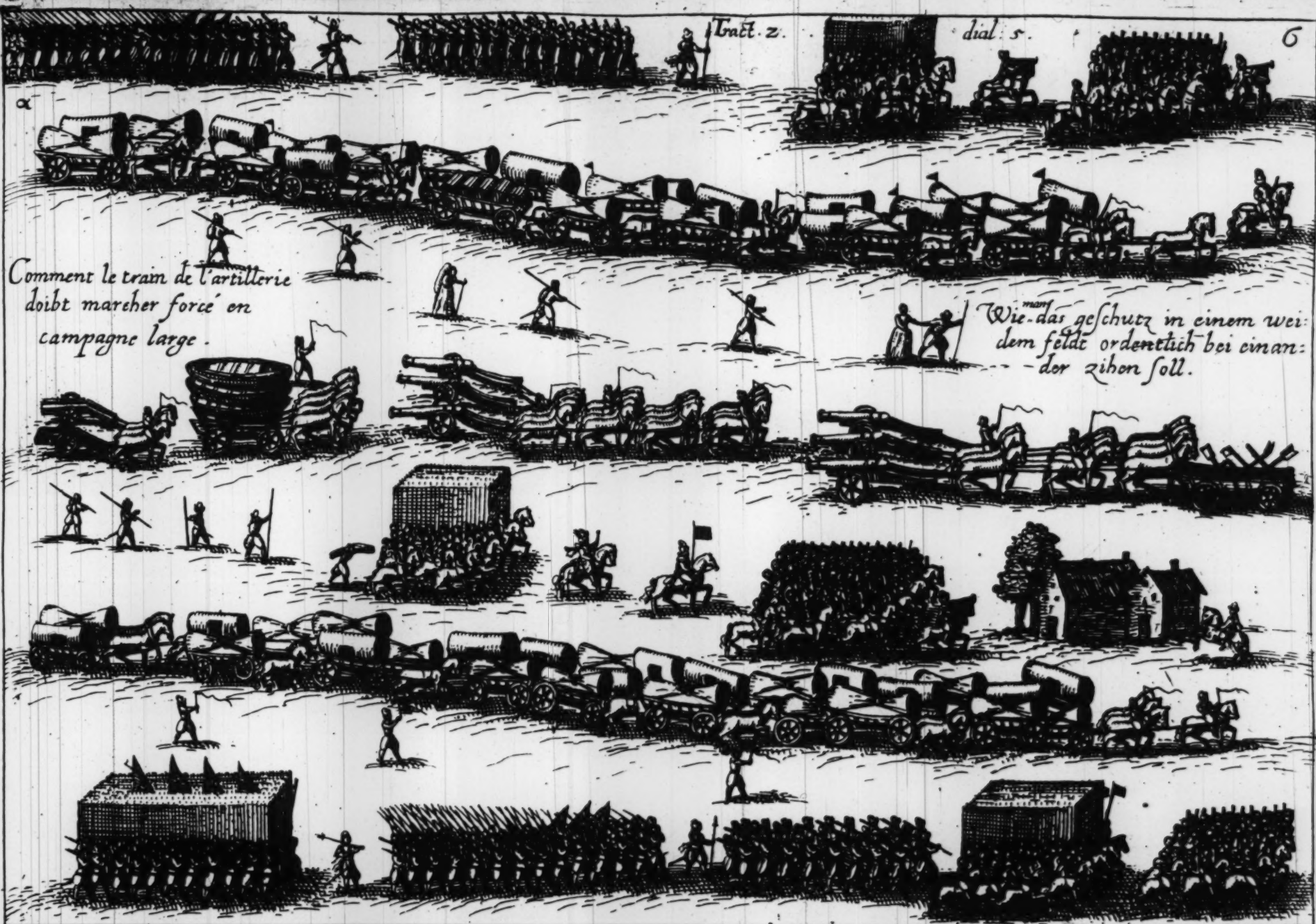
Canon en chariot.

Carthausn auff einem lastwagen

δ

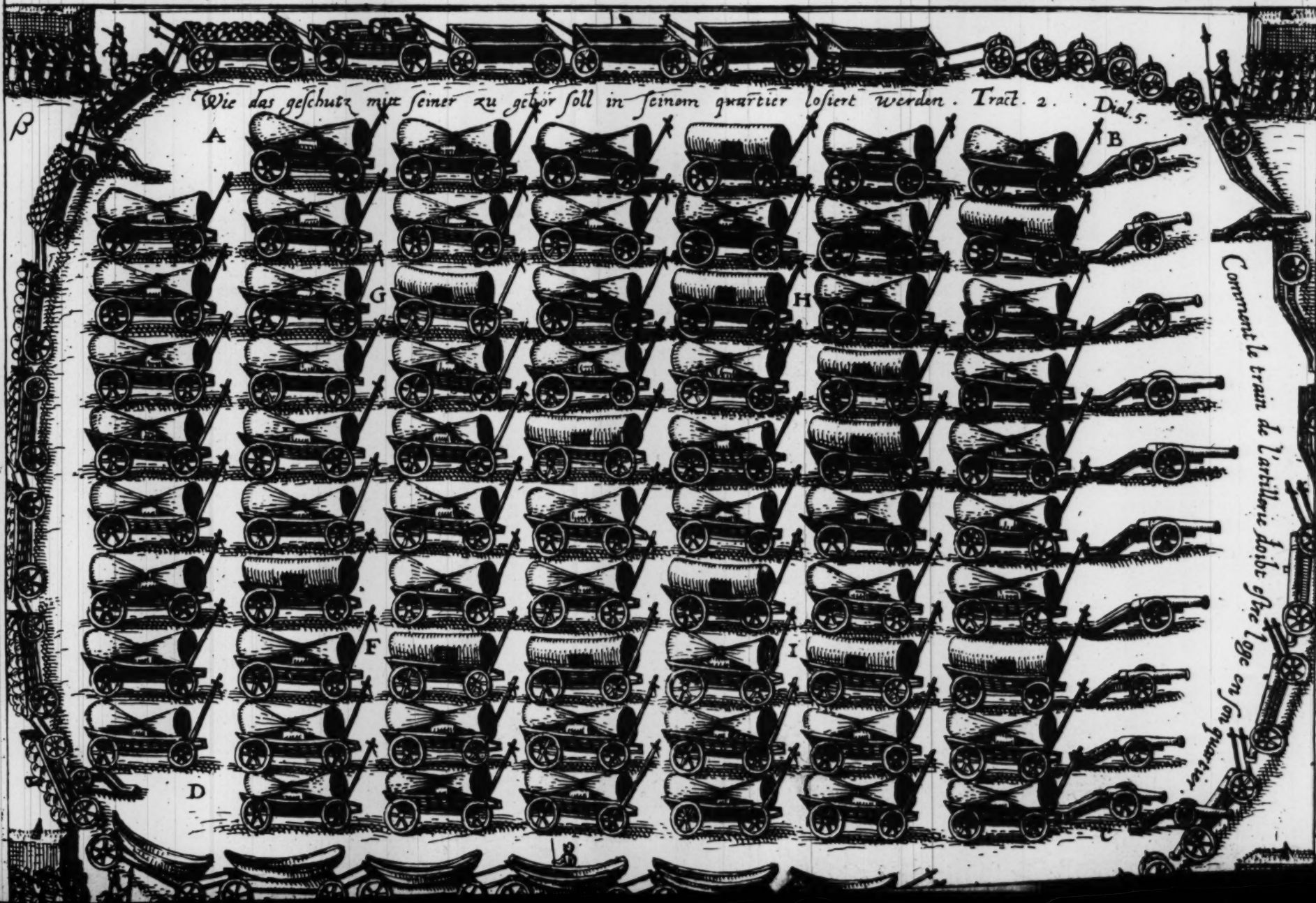






Comment le train de l'artillerie  
doit marcher forcé en  
campagne large.

Wie das geschütz in einem wei-  
dem feldt ordentlich bei einan-  
der zihen soll.



Wie das geschütz mit seiner zu gehör soll in seinem quartier losiert werden. Tract. 2. Dial. 5.

Comment le train de l'artillerie doit estre logé en son quartier.





The 4 Demy-Culuering Cariage, and all waighing about 2400 l. will require 40 men, to draw each of them, so 160 men will at 60 l. for each man serue to draw them.

The 6 Field Peeces with their Cariages, waighing about 2400 l. a Peece, will each of them require 30 men, so the 6 will be drawne by 180 men, each man drawing 60 l.

Now forasmuch as there may be cause often to dismount and remount a Peece by the way in the iourney, it will therefore bee fit to haue ready the *Gyndall* or *Winlas*, and the *Martinet* or *Gynne*, & when they are to be drawn vp any steepe hill, then also the *Capstone* Cable & *Pullyes* in the 2 last Chap. described, must also be caried, all which may be caried by 40 men with ease: so that for the Cariage and transportation of all these Amunitions in any iourney (where *Cattell* are not to bee had) may bee caried and drawne by 1675 men and a Boy without any difficulty.

It may also be demanded, because in such an expedition, that many other things will be needfull to bee transported for the Ordnances vse: As *Iron-workes*, *Nayles*, *Crowes*, *Hooes*, *Fore-Cariages*, *Grease*, and such like: But seeing they may more easily bee deuied amongst the Labourers, there resteth for them no difficulty of transportation. And for the better drawing of the Ordnance for each *Fore-cariage*, a long *Transome* or *Whiping-tree* must be fastned afore it, as betweene *A* and *B* is described, that the 3 *Ropes* or *Traces* may bee placed equidistantly, farre enough asunder to auoyde trouble, and because the *Traces* will be some of them too long, an other *Trauers* or *Whiping-tree*, or two may in the midst, or in conuenient places be fastned to those, or else other *Traces* rather may goe betweene *Whiping-tree* and *Whiping-tree*, to keepe the so long *Traces* from swaying, with too much trouble to stagger the men in drawing, and so hinder their draughts. And three men behinde would be needfull to guide the Cariage in the bendings and turnings of the way. Vpon the *Traces* also each man must haue a double Cord fastned to the *Traces*, which hee must put ouer his shoulder *Scarff-wise*, and laying his next hand on the *Tract*, hee may so draw with all aduantage.

And for Horse or Oxen, allowing each Horse to draw 500 l. and each draught Oxe 600 l. The same may easily be thereby found how many *Cattell* will be requisite to transport the aforesaid, or any other assigned quantity of Munition for any iourney. The manner of the Mannaging, whereof is represented in the said 5 Figure at *g*. And the carying of the *Shott* and powder in *Wheelebarrowes* and *Bagges*, is deciphered in the said 5 Figure at *v*. And lastly, the description of a Peece ready furnished for a iourney, with Cariage and *Fore-cariage*, *Ladles*, *Spunge*, *Ramers*, &c. is in the same Figure represented at *d*.

## CHAP. LV.

*How many Priuiledges the Trayne of Artillerie haue more then ordinary in Marching and Lodging.*

**I**F it happen that in Marching, any other Cariage offer to aduance before any of those of the *Traynes* Carriages (except the Treasurers Cariage) then the Master of the Ordnance hath power to command & compell the contrary by Priuiledge, whereof they enioy more then others, because of the extraordinary waight of the Ordnance and Short, and for that they haue charge of the principall instrument of the Warres, and therefore hath the first Ranke, without contradiction, and ought to haue the best Quarter and Lodging, and to be first settled therein. And in March in a Champion they of the Trayne of Artillery, are to march more close and short, then doth the Vant or Reire betweene which two and the *Batallion*, they are alwayes ranged or placed, as may appeare in the 6 Figure at *a*. And the Generall or Master of the Ordnance, is to haue care that his Trayne bee timely lodged, to haue time to prouide all commodities needfull. And if it were possible that they may be so lodged, as to discover the whole Champion about them, whereof these aduantages would arise: First, that they may discover all approaches: secondly, that the Campe may bee the better defended thereby. And thirdly, the Enemie aduancing to giue an assault to the Campe, they may by them the better be repulled. But for their Lodging, the order represented in the said 6 figure at *b*, it must be obserued. First, that betweene the Retrenchments made with certaine Chaines of the Munition, and with the empty Carriages and Fore-carriages, they may bee enclosed, so that there may be roome and space, that the Footemen appointed for their guard and defence, may if neede be skirmish, which for that purpose, hold the places therein marked *A B C D*, hauing 25 paces breadth at the least. And secondly, that the Peeces of Aduice, whereof there are alwayes 3 or 4, regarding all the wayes of the Enemies Auenewes, which are ever ready charged and fitted in all things. And lastly, that the Carriages of powder be lodged in the middle, as about the centre or midst of the other Carriages, as you may see by the letters *F G H I*.

CHAP.



CHAP. LVI.

Shewing how to waigh a Peece of Ordnance, or a Ship sunke vnder water, and the proportions of all Mettalls and Ordinary stone, what, or how much they will waigh in the Ayre, and how much in the water.

**I**T being a certaine thing, that whatsoeuer is heavier then so much water, as the body of the matter thrusteth out of the place will sinke, and being lighter then so much water will swim, as *Nicholas Tartaglia* hath not only well collected frō the learned *Archimedes*, but also calculated not onely the proportions of all the ordinarie sorts of Stones and Mettalls, whether in Ayre or Water, according as they poyze in both; And also notably expressed their surrounded accidents, in his Treatise intituled by him *Nouo Scientia*, wherein he deliuereth as followeth. Namely, that ordinary Free stone, waighing 93 *l.* in the Ayre, will waigh but 48 *l.* in the water, which is neere as 2 is to 1 betweene the Free stone and water.

And that Marble stone that waigheth 7 *l.* in the Ayre, will waigh but 5 *l.* in the water, which is neere 7 to two, betweene the Marble and the water.

And Iron and Tinne that in the Ayre waigheth 19 *l.*, will waigh 16 *l.* in the Water: so Iron or Tinne is to water, as 19 is to 3.

And Brasse waighing in the Ayre 65 *l.*, will in Water waigh but 55 *l.*, and so Brasse is to water, as 65 to 10.

And Lead and Siluer waighing in Ayre 30 *l.*, will waigh in Water but 27 *l.*, so Lead and Siluer are to water, as 10 to 1.

And lastly, Gold in Ayre being 17 *l.* waight, will in the Water waigh 16 *l.* so Gold is to Water as 17 to 1.

And in the first declaration of his said Booke, he sheweth how by a Concaue Globe of Glasse, hauing a hole to put in a mans head vnder it, being set in a Frame of Tymber in the forme of the Frame of an Houreglasse, with a Winlas, Rope, and waight thereat to sink. A man entered into that Frame, to the bottome of the Sea, or other deepe water, his head being within the said Concaue, Glasse, Globe (wherein he may both see and breath, being no water can enter into the same.) And when he will againe rise to the top or surface of the water, vnwinding the Rope (being long enough) the frame and his body in it, will in like manner mount vp as hee pleaseth: and the waight remaining at the bottome of the water, and the Rope going through the bottome of the Frame, it will guide it to goe vp vpright.

And in his second declaration thereof, he setteth downe the principall impediments, that vsually hinder in the waighing of a Shippe, or other heauie thing sunke vnder water.

First, if it be docked, or haue made his bed, or impression at the bottome.

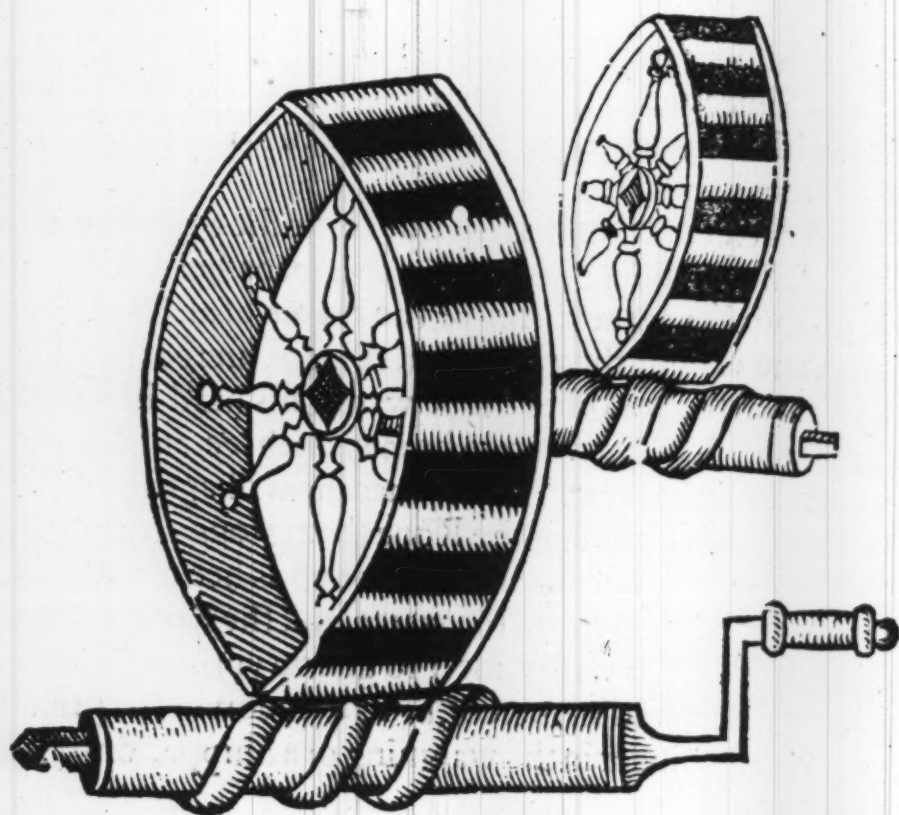
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Secondly,

Secondly, if it be filled or couered with Sand or Oaze, so that sufficient Ropes cannot be fastned thereunto to sling the same.

Thirdly, how to get the thing sunke, to seperate it selfe from the bottome of the water, where Ayre cannot come betweene, which will be harder to cause such seperation, in muddy, oazy, or sandy ground, then in grauelly or stony rocky bottomes; yea, and with more difficulty to, in very deepe then in shallower waters.

And lastly, that it is harder to waigh things that haue beene long, then such as are but newly sunke, because it and the bottome will bee so ioyned and closed together, that to seperate them, Nature refusing to let vacuity to come betweene them, they at the first will bee found loath to depart. But having fastned Ropes to sling the sunken thing, either by his helpe sunke in the said Frame, or else by the meanes here in this 14 figure at *e* represented, which may be conceiued, a man entered into a case of leather made so thight, that no water can soake in, and with a payre of glasse Spectacles fast set, and cemented close, with a pype of leather boyed by bladders blowne, at the brim or top of the water, whilst he fastens the Ropes below. Then 2, 3, or 4 vessells being ankered ouer the place, and firmly fastned together with Timber beames, the slinging Ropes also fastned to a mayne Tymber betweene the vessells, being deepe loaded at the first, fastned of the said slinging Ropes, and after the vessells being vnloaded and lightned, will bee more boyant, and waigh to their power: Or else if the slinging Ropes bee fastned to their stems (they being loaded forward) and afterwards the loading remoued aft, towards the sterne of the vessells, they will then waigh all their Force: And where the water heightens much, if Ropes be fastned at low-water, at high water, they will haue boyed the sunke thing, or done their most force and helpe they could.

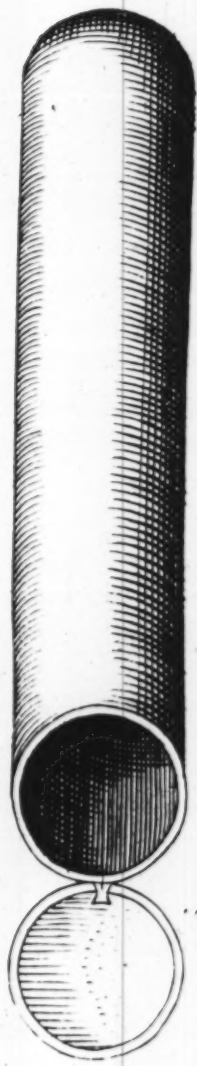
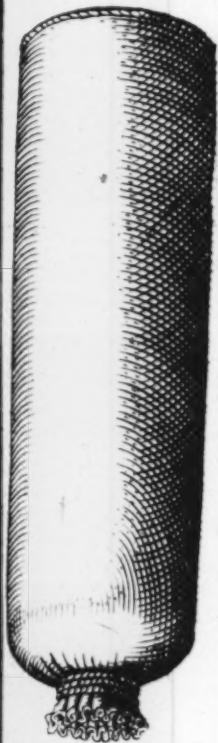


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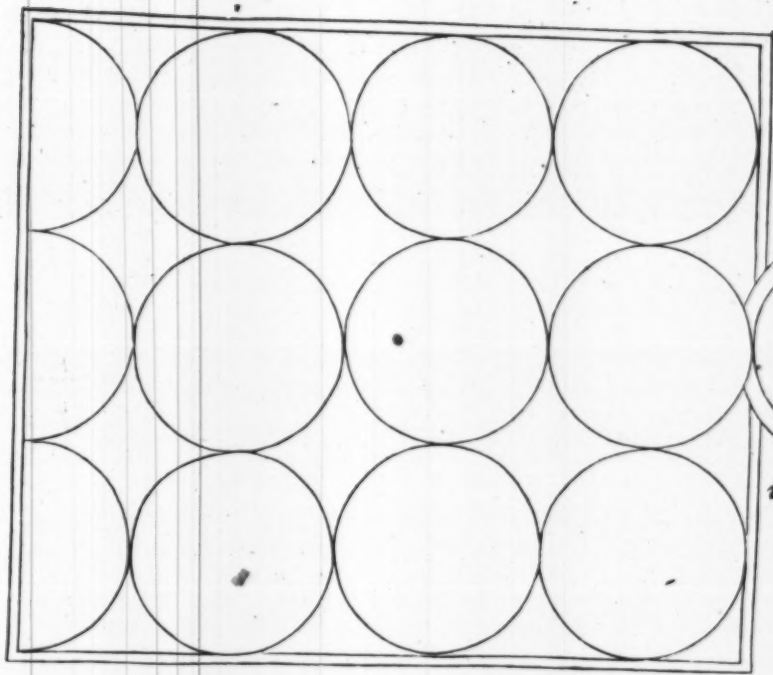
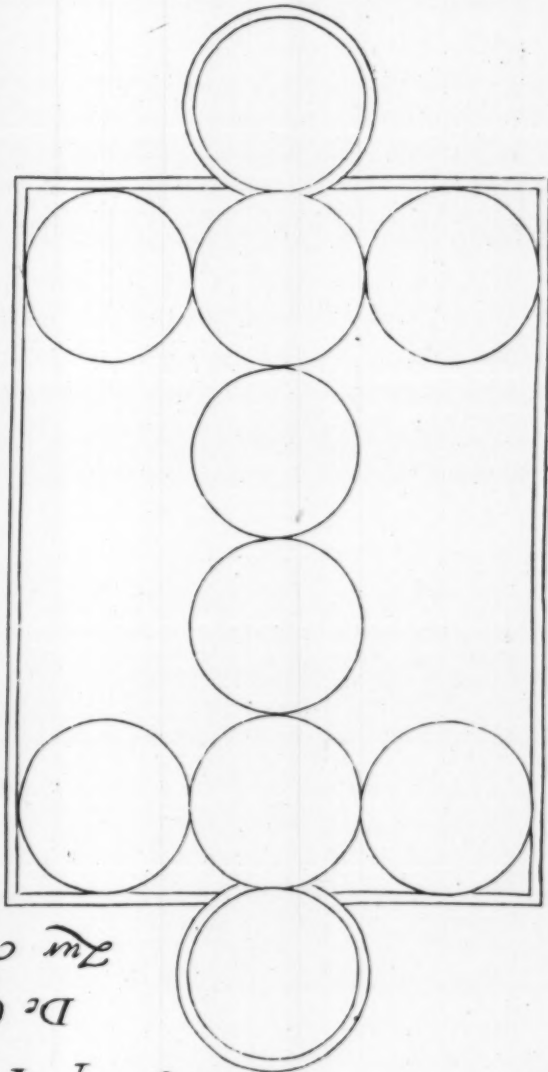
au défaut de sa propre cueillière.

Form und Maß der Secklein oder Patroben so im mangel der rechten  
ladtschaffeln gebraucht werden.



De Colubrine  
Zur Colubrinen.

Tract. 3. Cap. 4.



Pour le Canon  
Zur Caethannen

20





Lastly, also if 4 Vessells bee fastned, so that a square space be betweene, and one or two of *Archimedes* endlesse Scrues called *Tripastons*, here in a liuely figure, represented with which, bee said hee would moue the world out of his place, if he had a firme foundation to plant his *Engin* vpon *Datum pondus datis viribus mouere*: There will be therefore no doubt, but industry and diligence ioyned, will produce the wished effect: and so knowing the lading or waight of the Ordnance in the Ayre, as each thing would waigh in a payre of Ballance, the matter being Mettalline, then *Tartag* his true proportions will helpe, or if other goods, then industry will soone finde how much all will waigh in water, which let suffice at this time.

CHAP. LVII.

*How Moulds, and Formars, and Cartredges are to be made vpon them, to Load and Charge any Peece of Ordnance, without any Ladle.*



HAuing already shewed how to loade any Peece with, and without a Ladle: Now I will shew how to make *Cartredges* ready for all Peeces, wherewith in time of seruice any Peece will bee more speedily and certainly loaded. *Cartredges* are either to bee made with Canuas Fustian, or other linnen cloath, or with thicke strong Paper, specially of Paper Royall: which prepared, take the height of the bore of the Peece, without the vent of the Short, and cut the cloath or paper of the breadth of three such heights, and in length, for the *Cannon* 3, for the *Culuering* 4, and for the *Saker Falcon*, &c. 4; of the heights of their proper Bores, and leauing in the midst at the top and bottome one other such height, at each place to make a couer and bottome for the *Cartredg*e, cutting each side and end, somewhat larger, then the strict measures appointed for the sowing or glewing of the seames thereof, so much as will counteruaile the same, hauing also a respect for augmenting and deminishing those measures, as the powder shall bee better or worse then ordinary, and also abating with discretion, when as your Peeces shall be already heated in fight, least else you endanger the breaking or splitting of your Peece. Hauing resolved then for what sort of Ordnance your *Cartredges* are to serue, you are accordingly to haue a Modell or Former of wood turned of the height of the Shot, and of a conuenient length, longer then the *Cartredg*e is to be. Then if you make them of Canuas, halfe a diameter is to be allowed more in breadth for the seames: but if they be made of Royall paper, then hauing lapped it once about the Former, leaue about  $\frac{1}{2}$  inch surplussage more then will compasse it, which with Starch, Paste, or mouth Glew, close about the said Former, hauing some part of the same substance, fitted vpon the end of the Former; first for a bottome, which must also be pasted or glewed close, and fast to the side of the *Cartredg*e, so that being dry, it may hold the Powder fast, and sure from spilling. And you must



must remember first to tallow the said Former, so that the *Cartredg*e being so moulded thereon, it may be easily and without tearing, slipped off againe. A patterne for these *Cartredges* is here in this 20 figure represented. Now hauing shewed how the *Cartredges* are to be proportioned and made, it resteth also to shew how a peece of Ordnance is to be loaded with them, wherein we are onely to consider, that if the Peece be Chamber-bored, it must be layde in a Scaffeta, or Semicircle, or Cillinder of wood, of the thicknesse of the *Orlow*, or different thicknesse, or height of the Mettall betweene the Chamber and Chase, or else the *Cartredg*e will be hardly gotten into the Chamber. Also if the Peece were Taper-bored as the *Drakes*, and some ancient *Cannons* are, then the Mould, must accordingly be made to taper for the making of *Cartredges* for her, and her Ladle must also be cut tapering-like, the figure represented at T in the last figure but one; but if the Peece be equall bored, and the *Cartredg*e made of Paper, then there is no more to doe, but to put the *Cartredg*e into the mouth of the Peece, and with the Rammer-head, to put it home, to the bottome of the bore of the Peece, with two or three easie stroakes: and then with a sharpe three squared Pryming Iron, to cut and pryme the *Cartredg*e, that the Powder prymed at the *touch-hole*, may giue fire to the quick powder thereby. In all other things for wadding before and after the Shot, and ramming home the Shot, you are to performe the vsuall manner taught in his proper place.

### CHAP. LVIII.

*The names of the principall members, and parts of a peece of Ordnance, as they are to be called and knowne by.*



He names, kindes, and sorts of each Peece of Ordnance, with their differences, waight, measures, and in their fortifications, being already handled in the precedent *Chapters* hereof, needes not here be repeated. But in regard the most of them haue speciall parts common, and of like names, I will speake a word or two thereof, and so proceede to the manner of making and proportions, belonging to the *Cariage* of each particular Peece, as in the next Chapter will appeare. The whole peece together, or as much thereof as is matter of Mettall, may by the 2 definition of my Booke of the Art of Artillery, be called the body of the Peece. The hollow Concaue, Cillinder, or Bore of the Peece, may be called the Soule, by the first of the same. The whole length of her shaft or Colume, is the *Chase*. So much of her bore as containeth the Powder and Shott, is the *Chamber*, or Charged Cillinder, and the rest of the same is called her Guide or vacant *Cillinder*. The two spindles or eminencies that come out about the midst of her chase, whereupon she (in her *Cariage*) is mounted or imbasd, are called her *Trunnions*. The most afterward pummell at her breech, is called the *Casacabell*.  
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Tract. 2. Dial. 24. fig. 1

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Comment tirer un batteau enfonce en l'eau.

Wie ein versenckten schiff auß dem wasser zu heben.



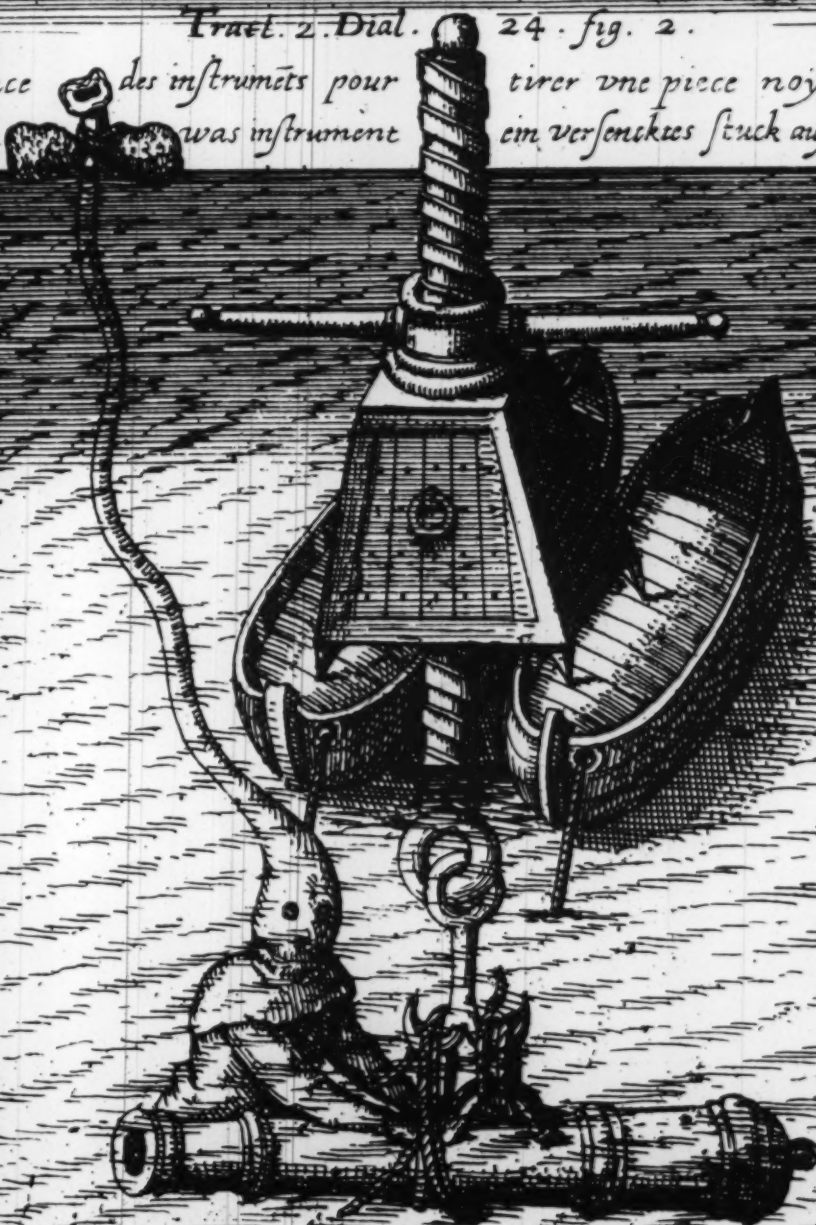
Tract. 2. Dial. 24. fig. 2.

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The little hole neere the breech, whereby she is prymed and fired, before her discharge, is her *Touch-hole*. All the Mettall behinde the Touch-hole is the *Breech*. The greatest and most eminent Ring or Circle of Mettall at the Breech, is the *Base ring*. The next Circle or Ring before betweene the Trunions and the Touch-hole, is the *Reinforc'd ring*: the Circle or Ring next before the Trunions, is the *Trunion ring*. And the Circle which is formost, and most ranke and eminent at her Mouth, is her *Muzzle ring*. Lattly, the Ring betweene the Trunion Ring and the Muzzle, is called the *Cornish ring*, and the part of the *Chase* of her shaft containd betweene the *Cornish* and Muzzle, is called her Neck. And all the Rings, Circles, and eminencies at her Mouth, are called the *Freize*, taking these names frō *Pillers* or *Columes*, which somewhat represent the Chase of Ordnance: being in forme of the *Scapus*, of a Piller or Colume so neerely, that they take the names of some such part of Pillers, as they neerely represent.

CHAP. LIX.

*Of the making Proportions and Measures of euery part of a Field Cariage for any vsuall Peece of Ordnance assigned.*

**I**T being most certainly a matter of great importance for seruice, to haue the *Cariages* of all the Ordnance, with their *Wheeles*, *Axtrees*, and their Furnitures to be strong, well proportioned, and neat, and gracefully wrought, so as the Peece mounted therein be euery way so duly fitted, as that in the discharge of her Shot, nor in her Reuerse she may not remoue from the Angle wherein shee was directed. Wee haue thought good here to shew the due measures and proportions for all Field Cariages, both by figures represented in the 19 figure at B, and also by rules and discourse as followeth. But first, a word or two of the reasons and different opinions of some of the best moderne Authors, that haue written of this subiect. *Louis Collado* affirmeth, that long *Cariages* are better then short: first for their more agillity in reuerling: secondly, for the much lesse shaking of the *Cariage*, *Axtrees*, *Wheeles* and *Plat-forme*, saying, that Ordnance mounted vpon short *Cariages* in a few times discharging them, make them viterly ruinous and vseruiceable by their passions in reuerse. But *Alexander Bianco* commendeth the short rather then the long *Cariages*: first, because they then requite lesse roome to reuerse in, and that being loaded, they are sooner brought againe to their place of seruice: And lastly, that a Peece shooteth further, being mounted vpon a short, then it would doe vpon a long *Cariage*. Both being moderated speake reason, as Peeces are yet accommodated: but because I know that any Peece of Ordnance may without any inconuenience be so fitted, that it with a short *Cariage*, it shall lesse shake the *Cariage* and *Plat-forme*, shoote further, and reuerse lesse by farre then in these as now they are fitted will do.

There-



Therefore although I with *Bianco* approue of short *Cariages*, were they fitted for them, and with *Collado* as they are yet fitted: yet I will here shew the measures and proportions of late vsed, of the best *Cariage-makers*, and are made according to the directions of the most experienced *Gunners*, which although it be most particularly appropriated to the *Cannon*, yet with the distinctions following it may well leade to the proportionall, making and measure of a good *Cariage*, for any vsuall peece of Artillery whatsoeuer as followeth. The sides and *Cheekes* called *Limbers*, ought to be of *Elme* or other Planke that is not apt to split and cleaue, which for the *Cannon* must be once and  $\frac{1}{4}$ , and for the Culuering and smaller Peeces once and  $\frac{1}{2}$  the length of the Peece, and for each of them, they must be one dyametre of the proper bore of the Peece in thickeesse and in breadth, at the head of the *Cariage*, it must be 4 dyametres, at the first bending 3, and at the tayle, 2 dyametres of the bore or height of the Peece.

The *Transomes* are to be in breadth 1 Calibre, and  $\frac{1}{2}$  of the bore, and in thicknes one Calibre, except the *tayle transomes*, & coyne, which must be 2 Calibres broad, and 5 long, whereof  $\frac{1}{2}$  Calibre may be let with a mortis into the cheeks at each end, and it must haue a bar of iron passe through the midst thereof from side to side, with a hole for the Pintle of the *Fore cariage* to enter into; on either side of this transome there must passe an yron bolt from one side to the other, with an yron or rose on each out side, to hold them firme together.

The next *Transom* forwards is the *Coyne Transom*, which must be 4 Calibres in length, that is 3 Calibres betweene the *Cheekes*, and  $\frac{1}{2}$  of a Calibre, let in at each end into the cheeke, vpon this the breech of the Peece is to rest his bed and coynes.

The next forwards is called the *bed Transom*, because the fore-part of the *bed* resteth thereupon, and the backer part of it resteth vpon the *coyne transom*. This is also 4 Calibres in length, but  $\frac{1}{2}$  Calibre at each end is likewise let into the cheeke neere to the *Axtree*, so 3 whole Calibres thereof will be left discovered betweene the cheeks.

The formost is called the *head Transom* or *fore-Transom*, which is 3 Calibres, and  $\frac{1}{2}$  in length, with  $\frac{1}{2}$  at each end also let into the cheeke, and so leaueth 2 Calibres, and  $\frac{1}{2}$  discovered betweene the sides.

Through each of these *Transoms* there must passe an yron bolt (at the least, for the greater sort of Peeces) from side to side: By meanes of these 4 *Transomes* all the *Cariage* is locked fast, as into one entire body, and is plated and bound strongly with yron, that the ioynts open not with the vehemencie of the reuerse. And thus is the *Cariage* in his perfection, so that if it were armed with his *Axtree* and *Wheels*, the Peece might be thereon mounted, and ready to doe seruice.

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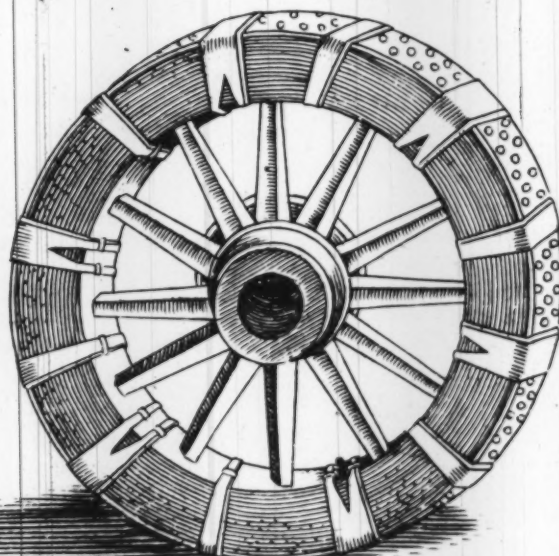
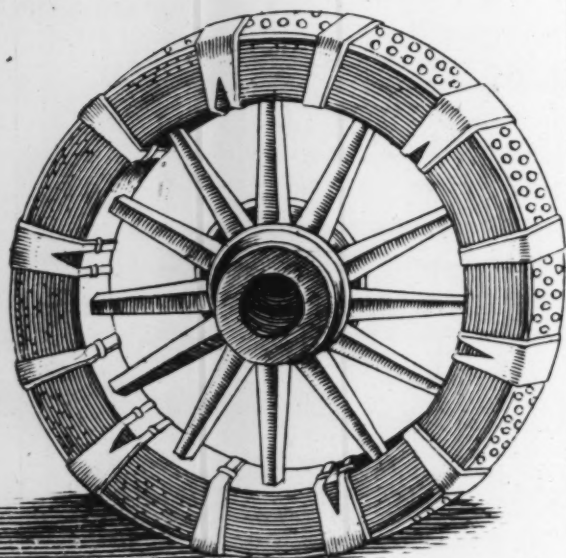
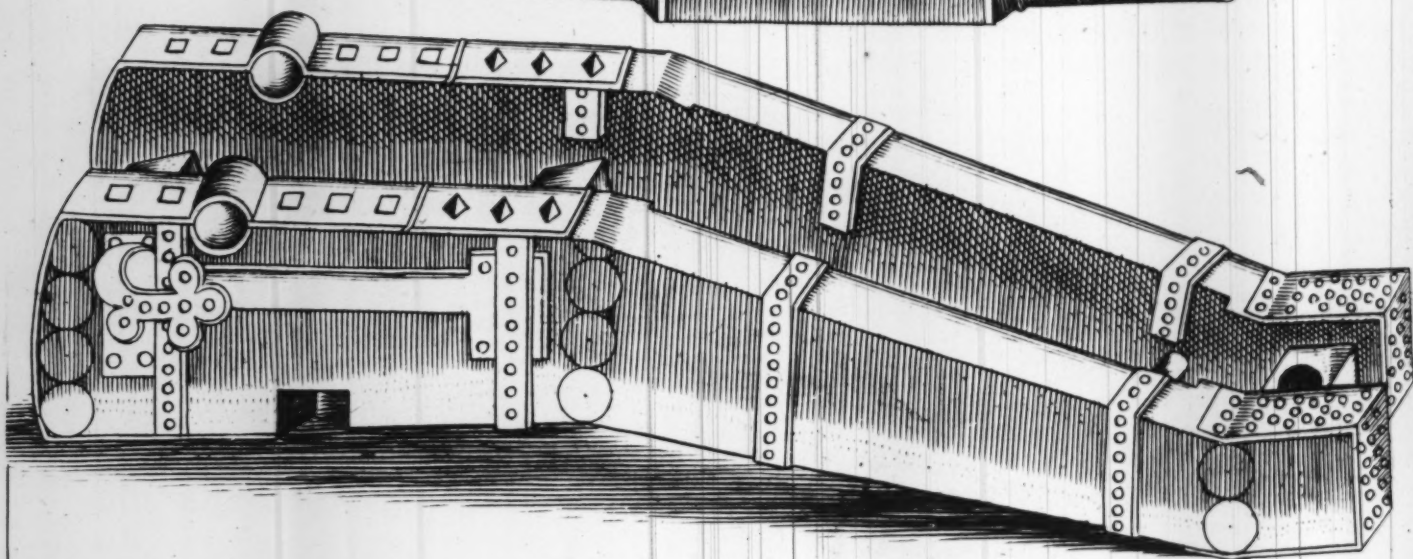
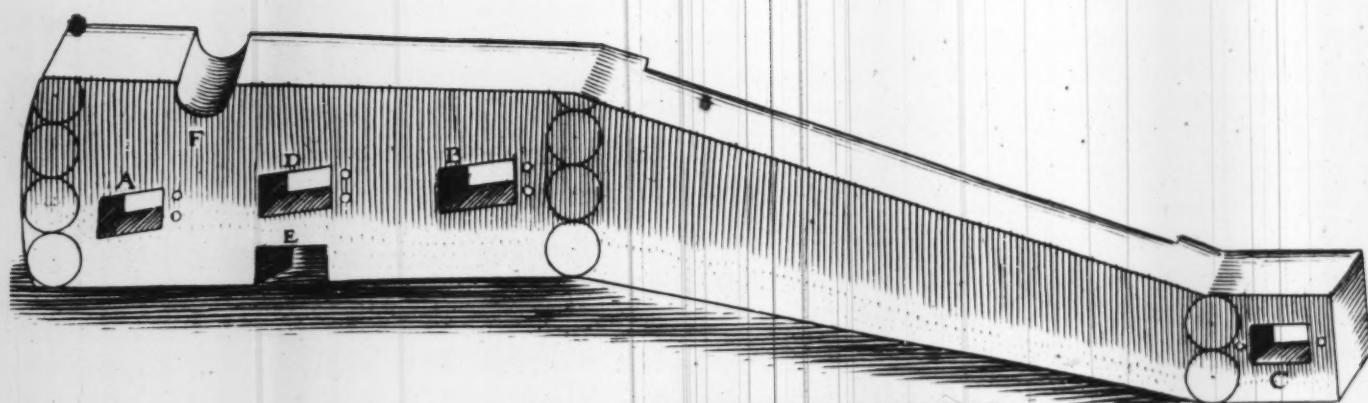
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*Tractat. 3. Cap. 7.*

19

B





CHAP. LX.

Of the *Wheeles* and *Axtree* for *Cariages*  
for *Ordnance*.



He *Wheeles* should bee in height about  $\frac{1}{2}$  the length of the *Peece*, but in that consideration must be had of the height of the *Parapet* where they are to serue. And for the *Saker*, *Falcon*, and smaller *Gunnes*, the height of their *Wheeles* must needs exceede that proportion, namely by  $\frac{1}{4}$  for the *Saker* and *Minion* and by  $\frac{1}{2}$  for the *Falcon* and *Falconet*, and by 1 quarter for the base. The *Fellowes* or *Circles* of *Timber-worke*, must bee in length 4 *diametres*  $\frac{1}{16}$  of the bore, whereof there must bee 6 to make the whole circumference, and each of them one *diametre* in breadth, and one in thickeffe: For the greater *Peeces*, they are to be shod with yron strakes, grasped and nayled with 2 or 3 *Ranke*s of great head *Nayles*, as in the figure 19 at *g* is represented.

The *Naue* or head is to be in thickeffe 3 *diametres*, and in length 3 and one halfe, armed with *Circles* or *Hoopes* of *Iron*, and fastned with stayes of *Iron*, that they stirre not from their places, nor goe round vpon the *Timber* of the *Naue*. The *spoakes* or *Rayes* are to be in length 3 *diametres*, namely so that being let into the *Naue* one halfe, and into the *Fellowes* one halfe, there may bee 2 *diametres* discovered betweene the *Naue* and the *Fellowes*. There must be 12 of these *Spoakes* in each *wheele*, each one quarter of a *diametre* square. The *Axtree* must be 1 *diametre*  $\frac{1}{2}$  in thicknes. The *Armes* thereof shall be in the thickest place one *diametre*, and at the ends thereof  $\frac{2}{3}$  of a *diametre* in thickeffe. And at the place where it pierceth the *Lymbers* or sides of the *Cariage*, it must be 1 and a quarter in breadth, and  $1\frac{1}{4}$  in height. As by the figure 19 *g* may appeare, wherein also the places where the *Mortis* for the *Transomes*, *Axis*, and *Trunions*, are marked with *A B C D E F*.

And for further explanation of that which hath beene already said, I will here set downe the particular proportions vsed therein for the whole *Culuering*, wherein the measures for the rest may the better be vnderstood: First, for the *Culuering*, the *Cariage* shall be once and a halfe of the length of the *Peece*, so that if the *Peece* be 32 *diametres*, the *Cariage* shal be 48 in length, and the *Wheeles* 11 *diametres* high. The *Naue* 4 high and 5 in length, the *Spoakes* 4 besides the one halfe let in at each end. The *Fellowes* two, and the *Arming* one. The *Axis* shall be in length 13 *diametres*  $\frac{1}{3}$ , and at the cutting of the *Cariage* therewith to bee 2 in breadth, and 2 in thickeffe. The *Limber Planks* or sides of the *Cariage* must be 4 and a halfe, or 5 *diametres* broad, one thicke, at the *Trunions* 4, and at the *Tayle* 2 and a halfe; the rest may be conceiued in the former figure 19, made for the *Cannon*.

Now to make the *Cariage* for the *Demi-Cannon* or *Demy-Culuering*, you may add to their former proportions  $\frac{1}{16}$ , so that instead of one *diametre*

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let  $\frac{21}{37}$  be placed, which proportion should be constantly held in all the measures propounded.

The like may be said for the Saker and Minion, in stead of one take  $\frac{11}{12}$ , and for the Falcon for one take  $\frac{7}{8}$ , and for the Base, &c. in stead of 1 take  $\frac{12}{13}$ . And so these measures being necessarily added, may suffice, as well for gracefull shew, as vsfull seruice.

### CHAP. LXI.

*Of the making of Candlesticks and Blinds, and of great Sauffons and little Sauffons, and little Saucigdes, and of the inuentor and seruice of them first vsed at Ostend.  
For hiding of Ordnance and men behind them, and to fill watered Dykes to approach a Breach.*

**T**He Candlesticks are made in the forme described in the next figure 15 at  $\gamma$ , and are of such height, as being cloathed with *Blinds*, of Canuas, Sedge, or such like light things, they may behind them couer and hide those that worke in the *Trenches*, or labour in *Batteries*, hauing the one Poynt or *Piramis* distant from the other in such sort, that 2023 Saucigdes, or more, or Bauins, or bundles of Sedge, may be placed betweene them one by another, but of what wood it shall be best, is not fit to appoint, seeing that if it be good, and sound, and light with all, to transport with them, ready cloathed from place to place.

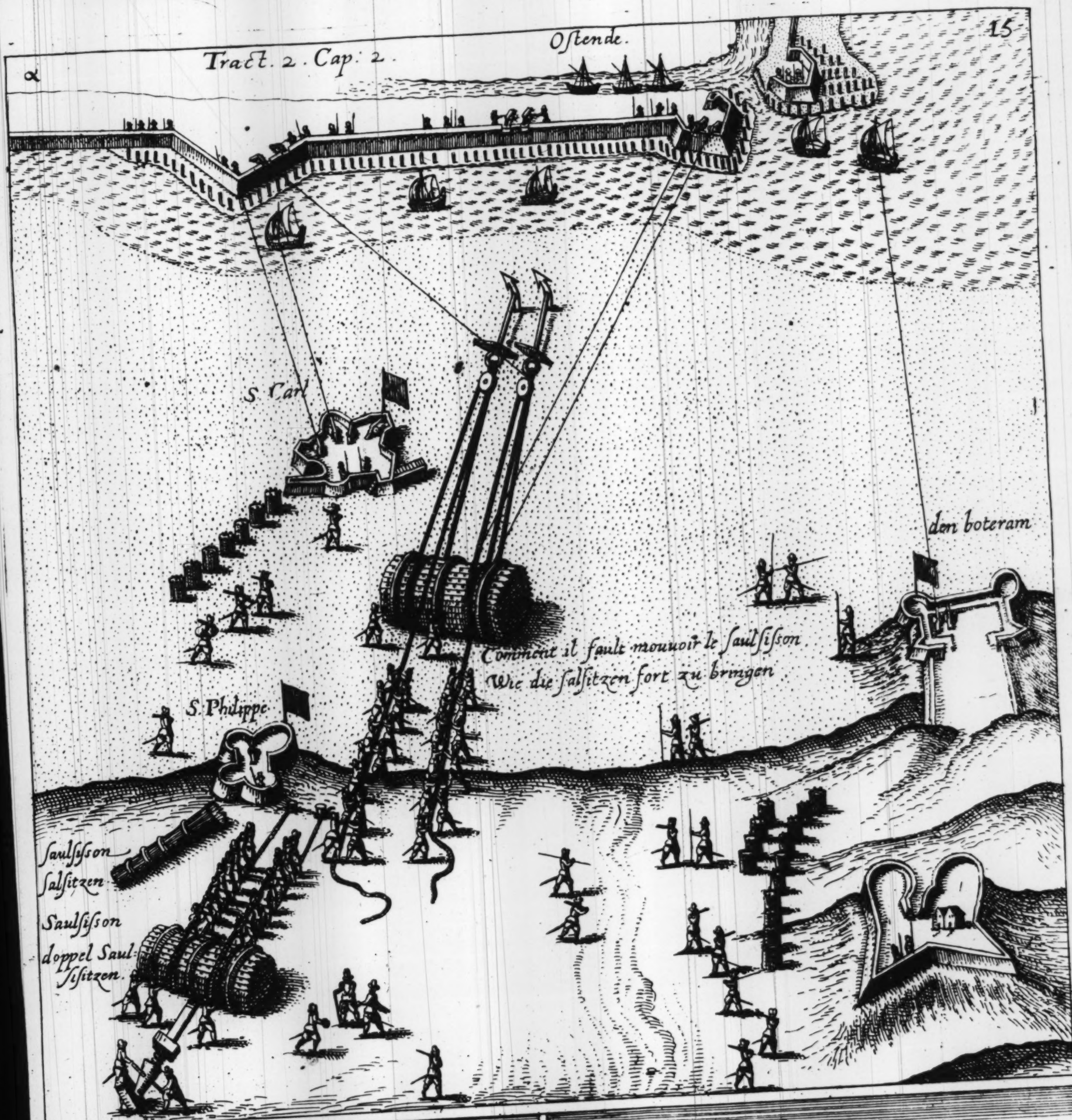
These *Candlesticks* are very necessary to make *Blinds* of prooffe, as were scene at the Siege of *Ostend* in *Buckuoy* his Ramparts, where his double and great Saucedges were not alone able to couer the Fabrick.

They may also serue in ouertures of *Trenches*, or in passing ouer *Dykes*, as was practised at *Rhinberg* in the Spanish quarter. They being by experience found to be singular good, especially in myrie places, in which reuesting them with Faggots, and setting them accordingly, men may passe by without any danger.

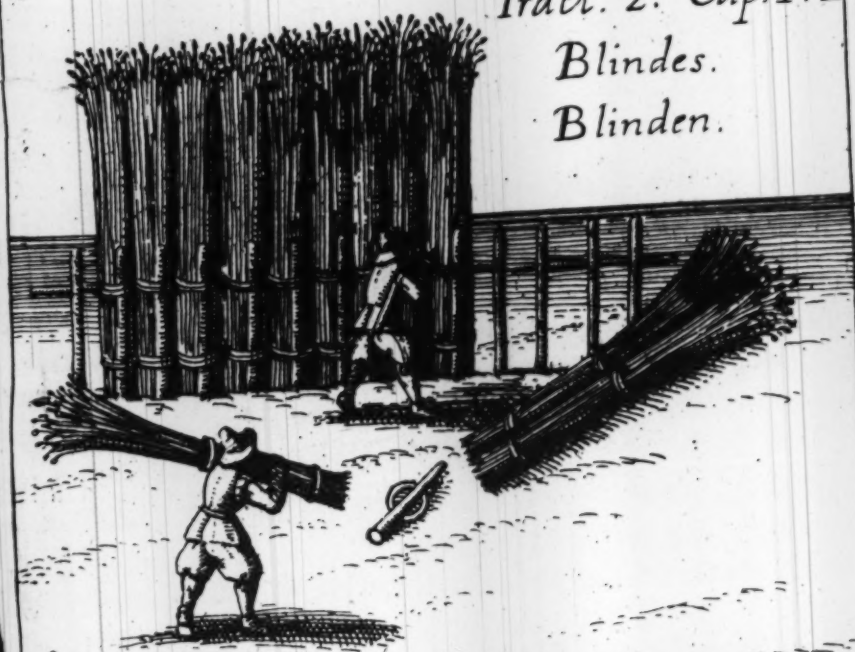
As for the *Blinds*, although their inuentor be not knowne, it being an old deuice, yet are they of singular vse, to couer for a while, and to hide our workes from the Enemies sights. They are represented in the next 15 figure also at  $\beta$ : For them certaine Stakes are pitched in the ground mans height as bigge as a mans legge, in number, according to the distance, as the couerture that is to be made requireth. being placed 4 or 5 foote one distant from another, enterlacing them with the longest bowes can be gotten, binding them close together. By meanes whereof, in one halfe day haife a *Cham* on may as it were be so couered, and all the Labourers therein hidden: was experienced at *Ostend*, and in the Isle of *Bomwell*: besides, that they so serue very commodiously for couertures of *Batteries*, and very comodiou



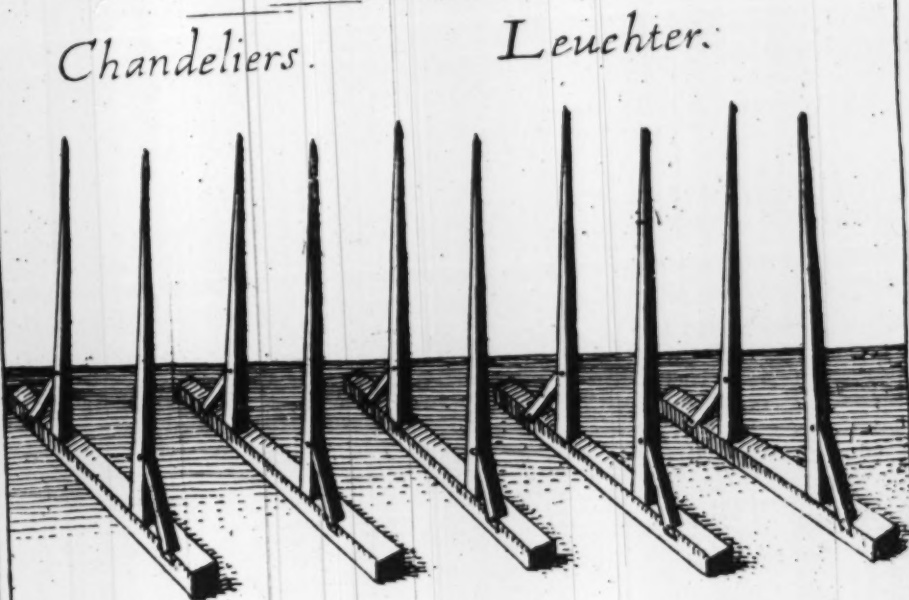




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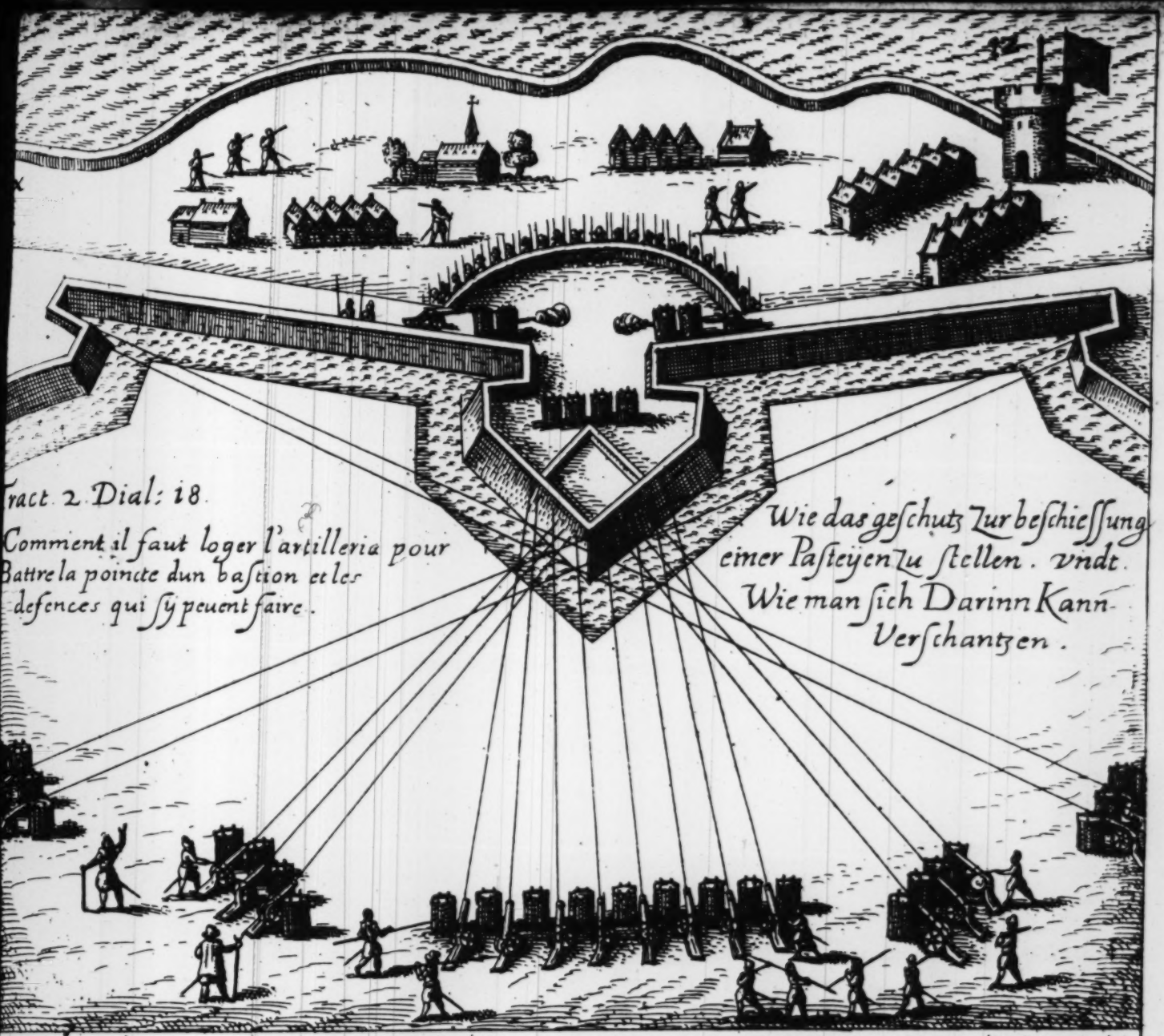


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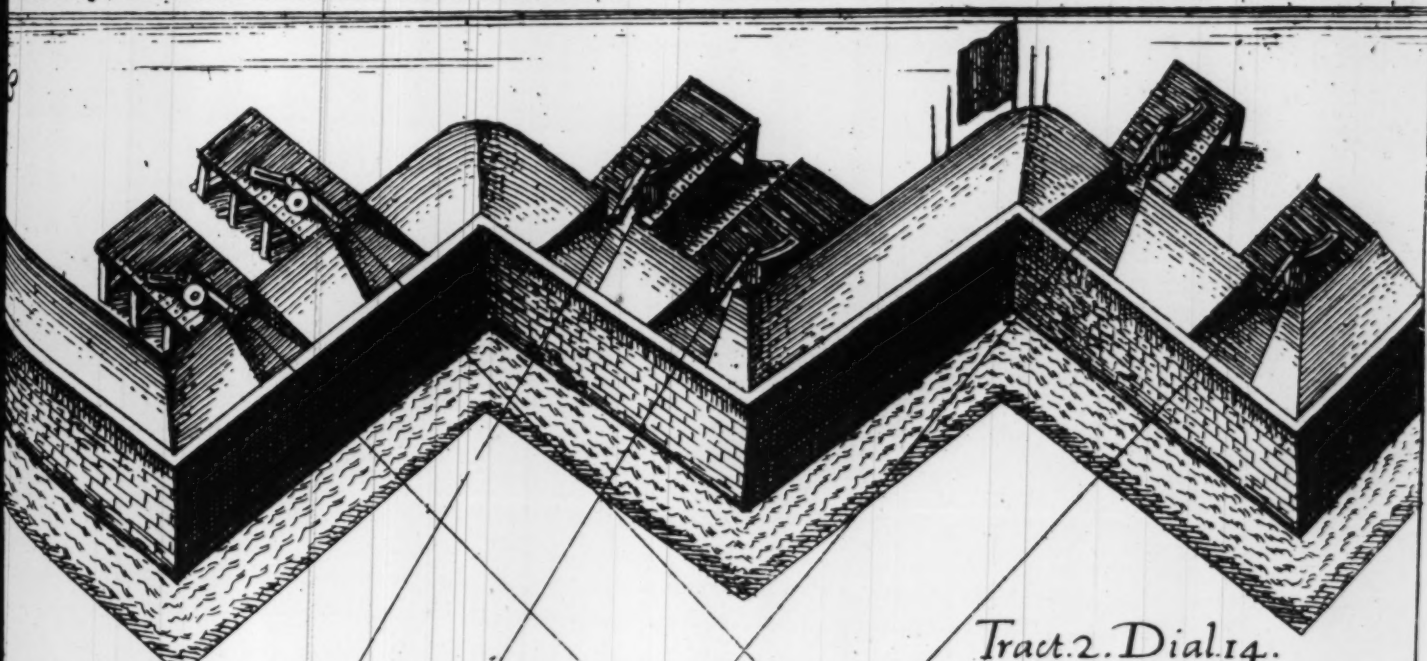




Tract. 2. Dial: 18.

Comment il faut loger l'artillerie pour  
Battre la pointe d'un bastion et les  
defences qui sy peuvent faire.

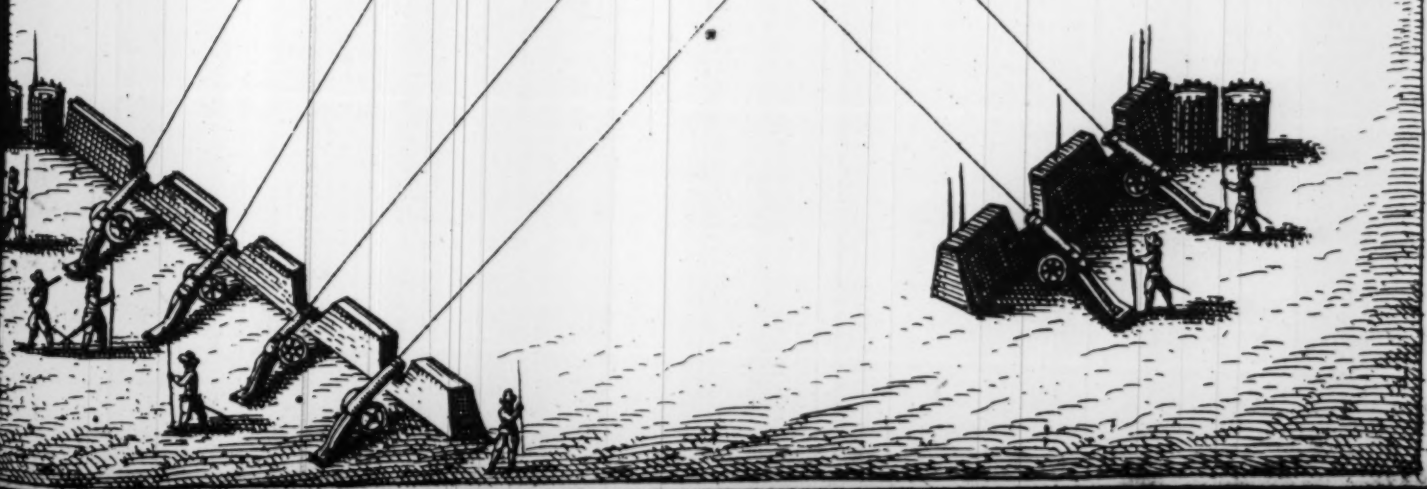
Wie das geschütz zur beschießung  
einer Pisteien zu stellen. vndt.  
Wie man sich Darinn Kann  
Verschantzen.



Comment il faut loger  
les pieces et les esleuer  
a faulte de terre.

Tract. 2. Dial. 14.

Wie man im mangel der  
erden auff einen gerüst  
erheben soll



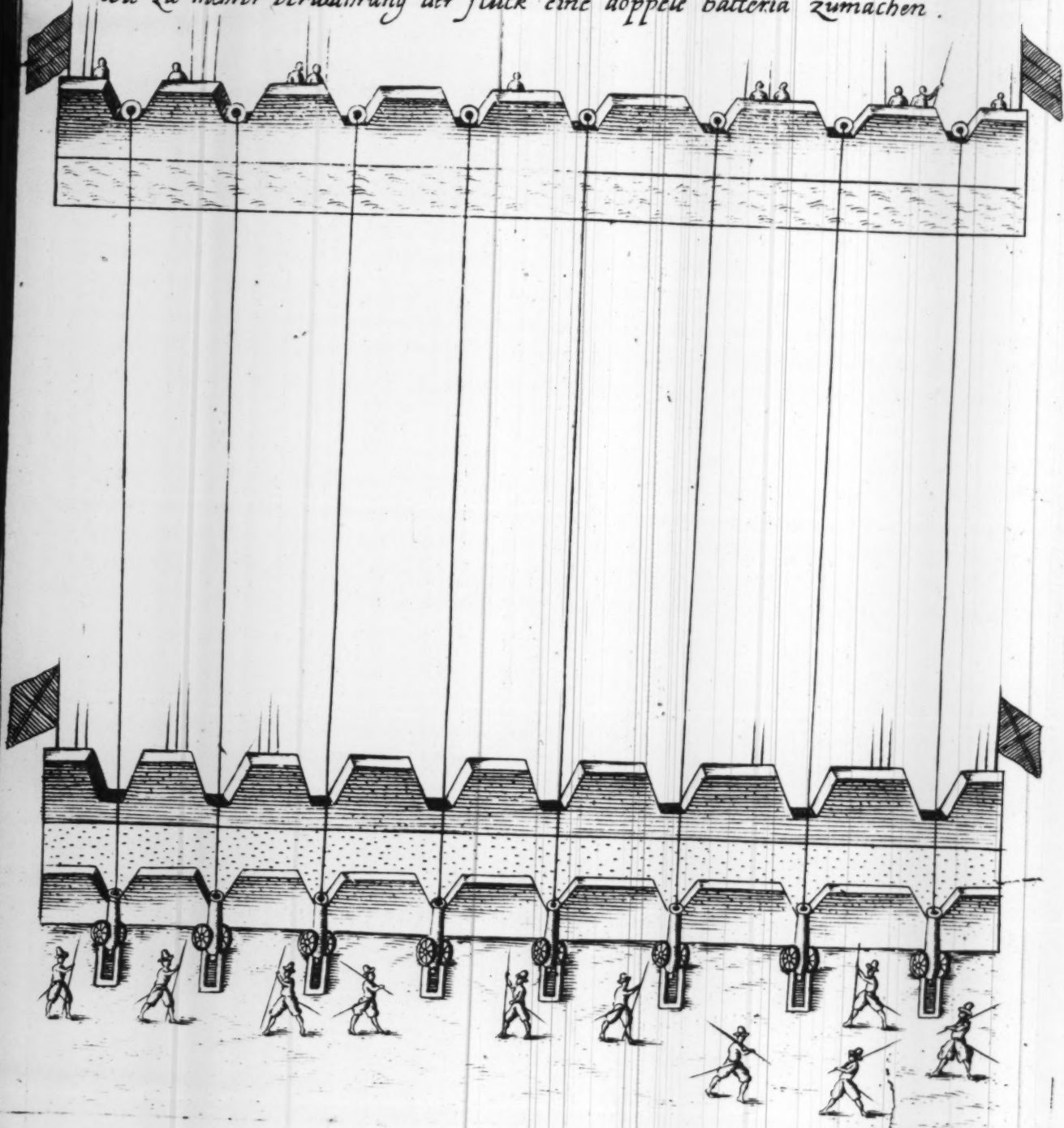


Tract. 2. dial. 13.

Comment pour plus grande assurance des pieces se fait vne double batterie  
Wie zu mehrer veruahrung der stuck eine doppelte batteria zumachen.

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diouſly (for water-works) *Sauſedges* were firſt made ſmall, inuented by one *Adrian Heranſon*, one wel experienced in making of *Dikes* and *walls*, and ſuch defences againſt *Water*, who both made alſo *Field Sauſedges*, which are ſingular to breake the violence of ſtreames of *Water*, to ſtrengthen *Dykes*, make *Walls*, and other ſuch like buſineſſes. After which, one *Chriſtopher Propergenius* perceiuing, that many *Sauſedges* ioyned faſt together, would make a great *Sauſedzion*, but to little profit, becauſe the exceſſiue bigneſſe thereof would not yeeld them meanes to moue it, vntill the *Count de Buquoy* diuided it, and thereof made 2 *Sauſedgions* better to be mannaged, whereupon they were afterwards vſed to reueſt *Candleſticks* as wee ſaid before. They were firſt made 46 foote long, and 15 foot dyametre, but were after brought to 23 foote long, and 12 foote euer-filled within with *earth*, and if to ſinke with *ſtones*, and in diuers places, as 3 at leaſt bound firmly together with yron Hoopes, and rowled to the places of vſe and ſeruice, or elſe with two Pyles or Anchors, Hawſers, and Blocks or Pullyes drawne thither by men behinde them, as in the ſaid 15 figure at *a* is repreſented to the eye: where- by an approach may be much the more ſafely expedited.

## CHAP. LXII.

*How to plant Peeces of Ordnance in ſecret Batteries, and in double Batteries, ſo that they may not eaſily be diſmounted by Counter Batterings.*



**I**F the Peeces appointed to make a *Batterie*, be planted vpon a plat-forme that deſcendeth behind, that in their reuerſes they may goe vnder the vawmure of the *Tronier*, the *Troniers* being vaulted, as in the *Caffamattes* at the 157, and 158 figures of *Marlois* is repreſented, they muſt by ſtrength and by Tackles bee brought vp againe aboue the vawmure of the *Tronier*, and the ayme to bee readily taken before the *Tronier* be opened, and fire giuen immediatly after the inſtant of opening it: So will they in their Reuerſes be againe got vnder the vawmure, and bee free from diſmounting, ſo long as the Furne mouth & Vawmure is able to keepe from the ruine of Counter-batteris.

There is alſo a meanes to ſaue Peeces from being diſmounted, namely by ſuch double defences as are repreſented in the 22 figure *β*, with ſuch *Battlements* or Loopes as are there vnderneath repreſented, then onely obſeruing that they be of equall wideneſſe, both before and next the Peece, and to make them equally deepe enough, ſo as the right line that may diſcouer the Enemies Peeces, lye right through each Loope one, then 10 foote more backward or forward, make ſuch another Batterie: As the ſaid figure will ſufficiently demonſtrate, ſo by thoſe two ſeueral Loopes the Peeces will be



so surely defended and hidden, that the Enemy shall very hardly discover them, much lesse shoote so precisely, as to dismount them through both.

### CHAP. LXIII.

*How to plant Ordnance, whereas the Rampart is too shallow for their Reuerse, and where earth is wanting.*



Orasmuch as such necessities may often happen, it will not bee amisse to shew how to supply the same when neede shall be: First, for each Peece take 6 Trees, high enough, strong, and straight; if 6 be not sufficient, take 9 or more for each Peece, which driuen deepe enough into the ground to hold them firme, and making each of them strong to carrie their burthens with Braces, Ioyces and Plankes, making thereon a Plat-forme 20 foote long, and of sufficient breadth, that the Peeces may both be manna-  
ged thereon, and also play and reuerse freely, remembering that thereon a Peece will more reuerse vpon this being leuell, then vpon a Plat-forme that riseth behinde, and will therefore without sufficient roome and care, endanger the Peece by her falling from aloft to the ground.

### CHAP. LXIIII.

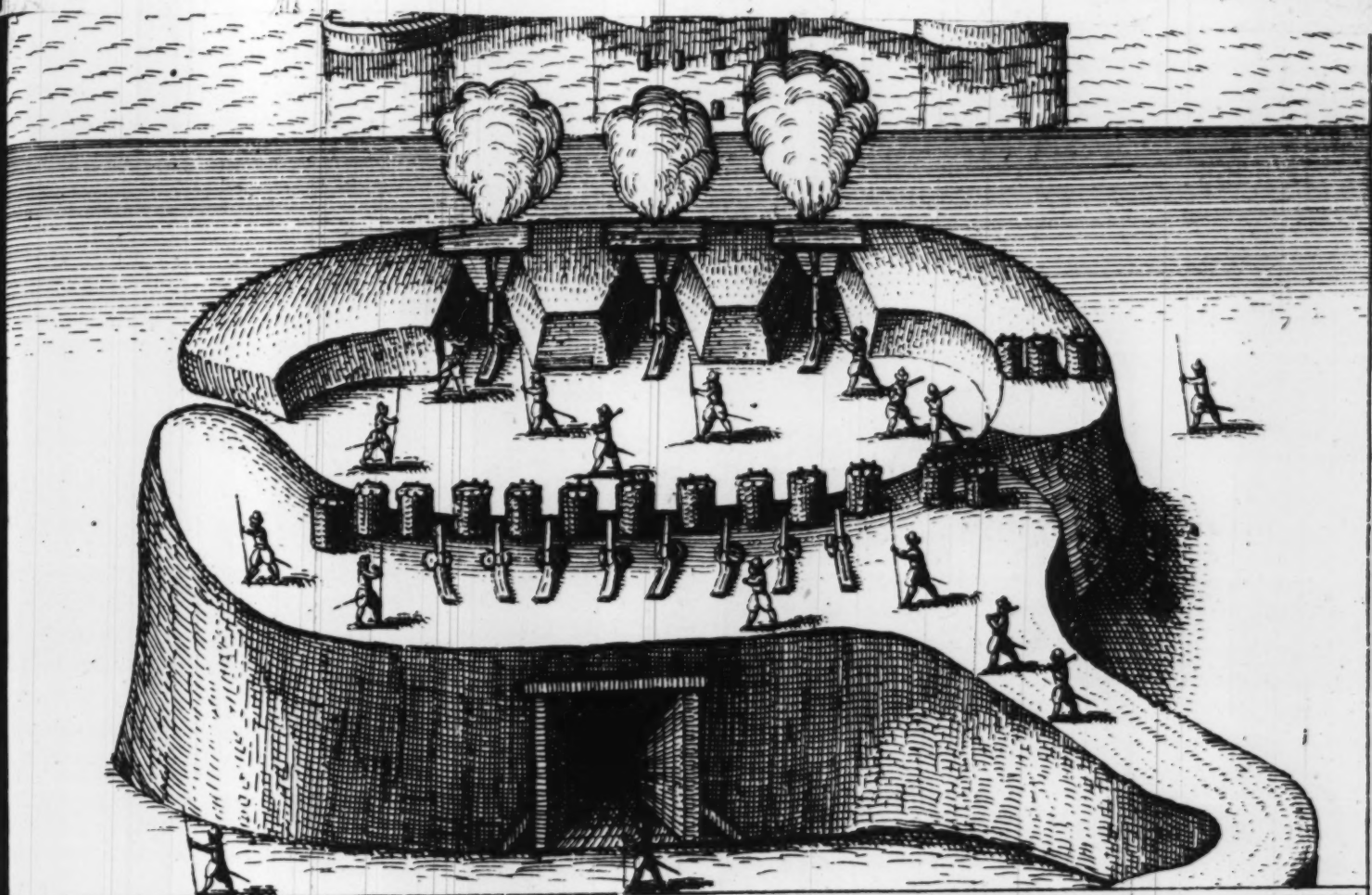
*How to make a Batterie with Peeces enterred.*



His manner of Batterie hath long beene vsed both in *Italy* and *Hungaria*, whereof the delineation following is a sufficient illustration, yet a word or two thereof: First, you may make out as much place vpon the side of some Hill or Mount neere, and raised of sufficient height, as will suffice to receiue your Ordnance, so that they may each stand 20 foote distant from one another. And then by the ayde of *Pioners* & other *Workmen*, make a *Dyke* deepe 11 foot, defensible sufficiently, be it forwards, artificially, or naturally, by thicknes from the bank or out-side of the hill, to the inside thereof, and so broad, as that people may passe behind the Ordnance, when they haue reuersed. And when you haue made Plat-formes, open *roniers* or Loopes through the earth of the side of the hill, so high, broad, and deepe, as you would haue them, which is a way so sure, that the Towne walls cannot any way hinder you therein, especially if it be in a naturall firme mould of *Earth*, if the blowing of the Pee-ces cause any of the earth within the *Trunier* to fall, a long Colerake will soone draw out the same, and you may also line it with Watlings.

CHAP.

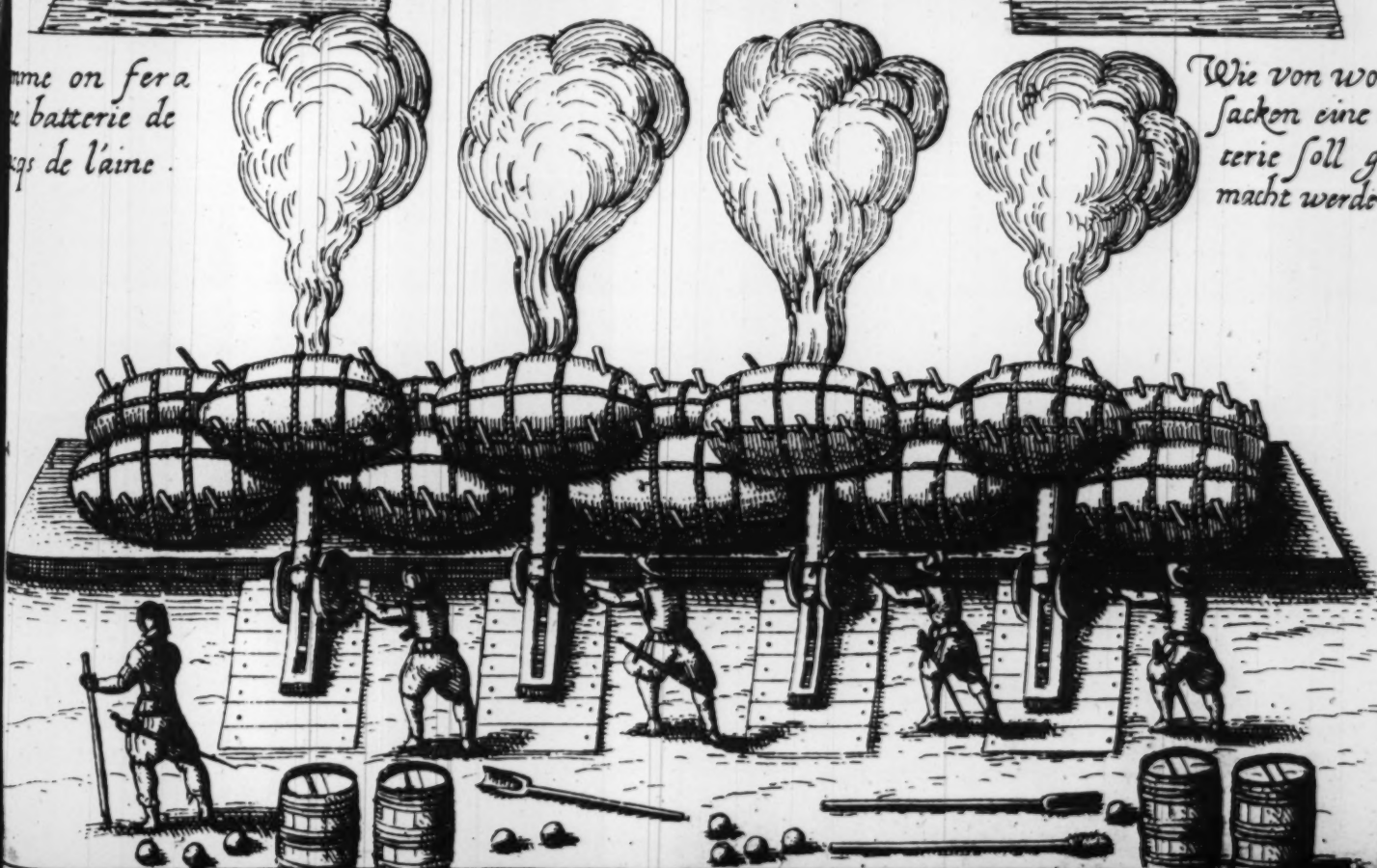




Tract. 2. dial. 15.



me on fera  
la batterie de  
sacs de laine.



Wie von woll:  
sacken eine bac  
terie soll ge:  
macht werden.





CHAP. LXV.

*How wanting all other meanes, to make a Batterie  
by Woollacks.*



Here none other but grauelly *earth* is to be had, thereto auoyde the shottering, that the *Enemies* Ordnance may make by the stones, to endanger the Camp, Woollacks, may make the Sholders and *Troniers* in such manner, as this figure 11 is represented. This is no new inuention, for it hath long bene vsed by diuers Nations: now it were necessary that these Sacks were 17 foote long, and 7 foote thick: And to resist the Cannon, there should be three in breadth to make the Shoulders or Parapets of the *Troniers*, and for the Demy-Cannon 2 and a halfe: And it is to bee vnderstood, that the two outmost of the three Sacks, must be somewhat shorter then that within, to giue sufficient ouerture for the *Troniers* without, that the blowing of the Peecces endamage them not, vpon the said ouerture 1 or 2 Woollacks should also be layde to serue in place of *Blinds*, for the trauerling and manning them the more safely: if by chance the Sacks doe any where take fire, there must be water and earth ready to quench the same, and to fasten these *Woollacks*, they must be Pyled with Pyles driuen into ground, all firmly bound together. Also if other Ordnance then the *Cannon* or *Demie*, there must be as many more Sacks of Wooll for shoulder defences, as that all the Peecces may bee well couered: as the vndermost of the 11 figure next manifesteth.

CHAP. LXVI.

*How to place great Ordnance, both to dismount the Enemies  
Artillerie, as also how to make a Batterie on the  
Curtin of the Place, and when.*



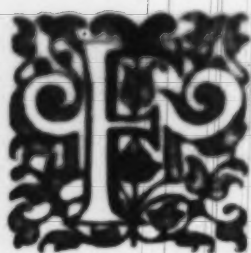
Lthough it hath bene a receiued opinion, that such Peecces as doe lye high on the walls, are in lesse danger, and haue more aduantage then such as are alowe in the Champion plane, because those aloft may more easily discouer those alowe then the contrary. Yet it is found otherwise by experience, as in the 9 figure is seen, wher the Peecces alowe, playing alwayes vnder the Peecces, aloft, doe and may well embouch them, or else not faile to cloy their Plat-formes, or beate their Cariages Wheels and Axeltrees, and so consequently makethem vnseruiceable, besides that if they take them



is surely defended and hidden, that the Enemy shall very hardly discover them, much lesse shewen to precisely, as to discover them through both.

## CHAP. LXIII.

*How to plant Ordnance, where the Rampart is the Wall  
to the River, and to be used  
in Battling.*



Inasmuch as such necessities may often happen, it will not bee amisse to shew how to supply the same when neede shall be: First, for each Peece take 6 Trees, high enough strong, and straight, if 6 be not sufficient, take 9 or more for each Peece, which driuen deepe enough into the ground to hold them firme, and making each of them strong to carrie their burthens with Braces, Ioyces and Plankes, making thereon a Plat-forme 20 foote long, and of sufficient breadth, that the Peeces may both be manna-ged thereon, and also play and reuerse freely, remembering that thereon a Peece will more reuerse vpon this being leuell, then vpon a Plat-forme that riseth behinde, and will therefore without sufficient roome and care, endanger the Peece by her falling from aloft to the ground.

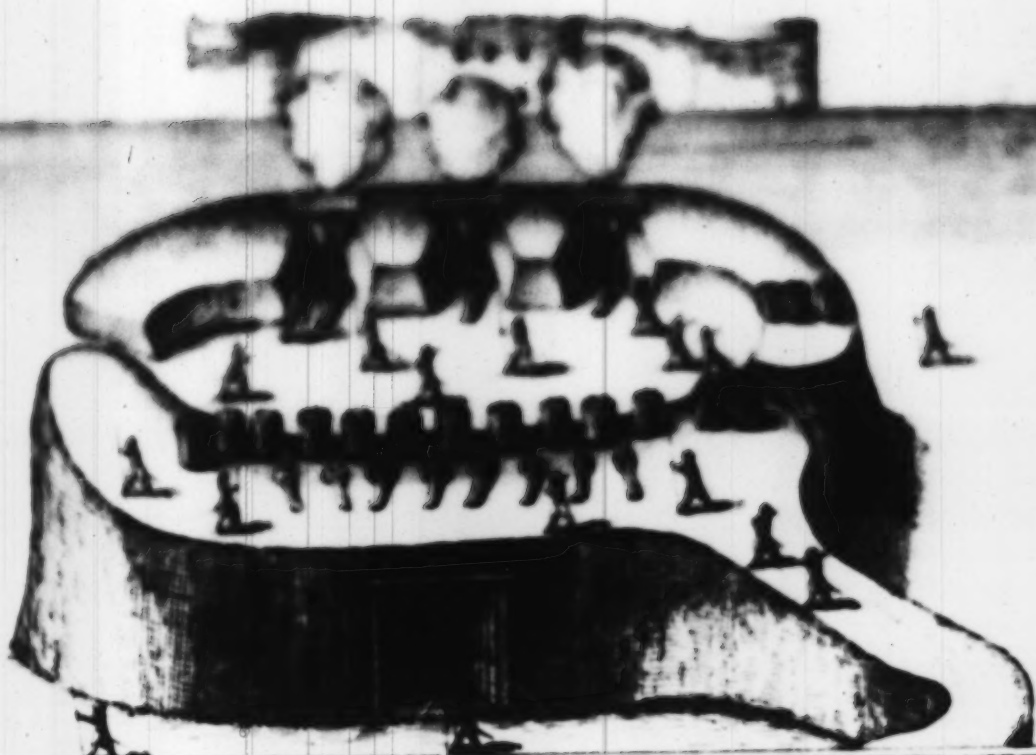
## CHAP. LXIII.

*How to make a Battery with Peeces enterred.*

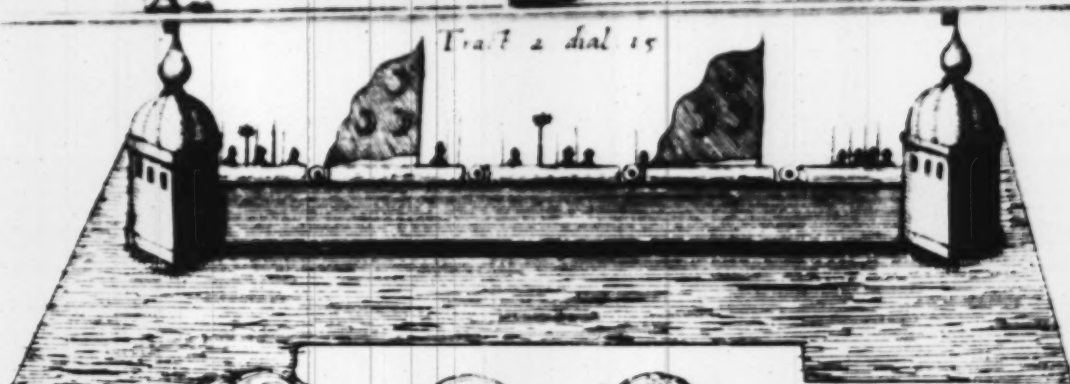


His manner of Batterie hath long beene vsed both in *Italy* and *Hungaria*, whereof the delineation following is a sufficient illustration, yet a word or two thereof: First, you may marke out as much place vpon the side of some Hill or Mount neere, and raised of sufficient height, as will suffice to receiue your Ordnance, so that they may each stand 20 foote distant from one another. And then by the ayde of *Pioners* & other *Workmen*, make a *Dyke* deepe 11 foot, defensible sufficiently, be it forwards, artificially, or naturally, by thicknes from the bank or out-side of the hill, to the inside thereof, and so broad, as that people may passe behind the Ordnance, when they haue reuerfed. And when you haue made Plat-formes, open *roniers* or Loopes through the *earth* of the side of the hill, so high, broad, and deepe, as you would haue them, which is a way so sure, that the Towne walls cannot any way hinder you therein, especially if it be in a naturall firme mould of *Earth*, if the blowing of the Peeces cause any of the earth within the *Trunier* to fall, a long Colerake will soone draw out the same, and you may also line it with Watlings.

CHAP.

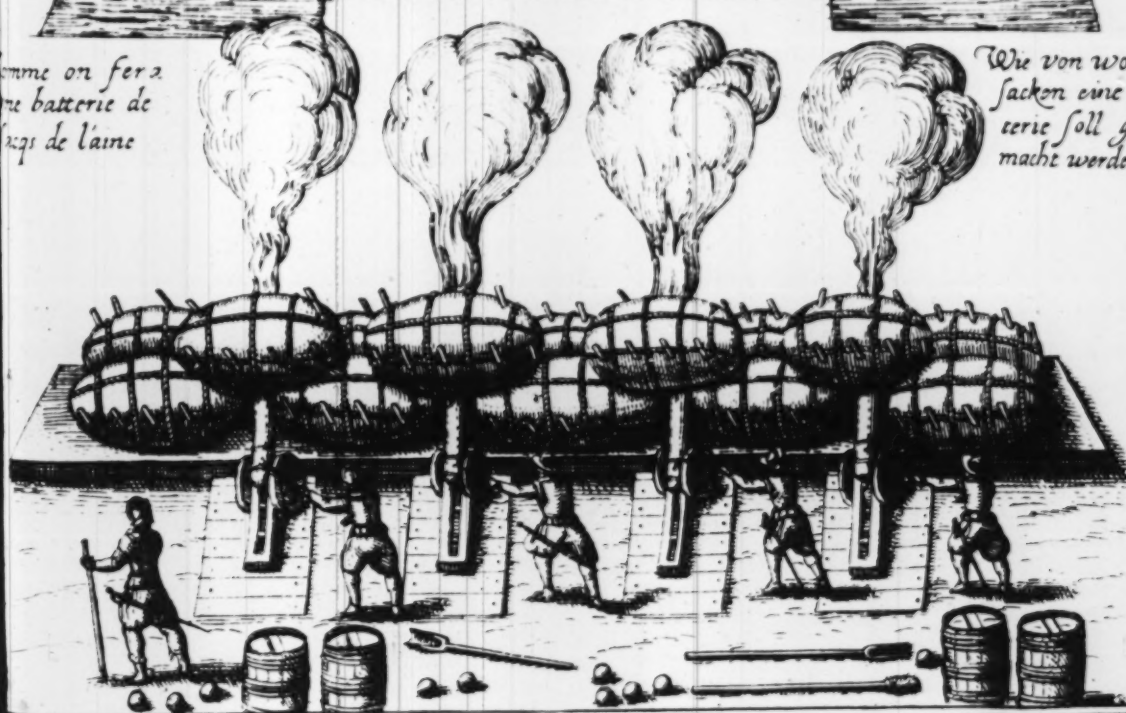


Tractat 2 dial 15



comme on fera  
une batterie de  
cannons de laine

Wie von woll:  
sacken eine bae  
terie soll ge:  
macht werden.



Comment on peut enterrer  
quelques pieces:

Tractat 2

dial 16

Wie eine versenkte batterie  
zu machen.

so surely defended and hidden, that the Enemy shall very hardly discouer them, much lesse shoote so precisely, as to dismount them through both.

## CHAP. LXIII.

*How to plant Ordnance, whereas the Rampart is too shallow for their Reuerse, and where earth is Wanting.*



Orasmuch as such necessities may often happen, it will not bee amisse to shew how to supply the same when neede shall be: First, for each Peece take 6 Trees, high enough, strong, and straight; if 6 be not sufficient, take 9 or more for each Peece, which driuen deepe enough into the ground to hold them firme, and making each of them strong to carrie their burthens with Braces, Ioyces and Plankes, making thereon a Plat-forme 20 foote long, and of sufficient breadth, that the Peeces may both be manna-  
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## CHAP. LXIII.

*How to make a Battery with Peeces enterred.*



His manner of Batterie hath long beene vsed both in *Italy* and *Hungaria*, whereof the delineation following is a sufficient illustration, yet a word or two thereof: First, you may marke out as much place vpon the side of some Hill or Mount neere, and raised of sufficient height, as will suffice to receiue your Ordnance, so that they may each stand 20 foote distant from one another. And then by the ayde of *Pyoners* & other *Workmen*, make a *Dyke* deepe 11 foot, defensible sufficiently, be it forwards, artificially, or naturally, by thicknes from the bank or out-side of the hill, to the inside thereof, and so broad, as that people may passe behind the Ordnance, when they haue reuerfed. And when you haue made Plat-formes, open *rouiers* or Loopes through the earth of the side of the hill, so high, broad, and deepe, as you would haue them, which is a way so sure, that the Towne walls cannot any way hinder you therein, especially if it be in a naturall firme mould of *Earth*, if the blowing of the Pee-  
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CHAP.



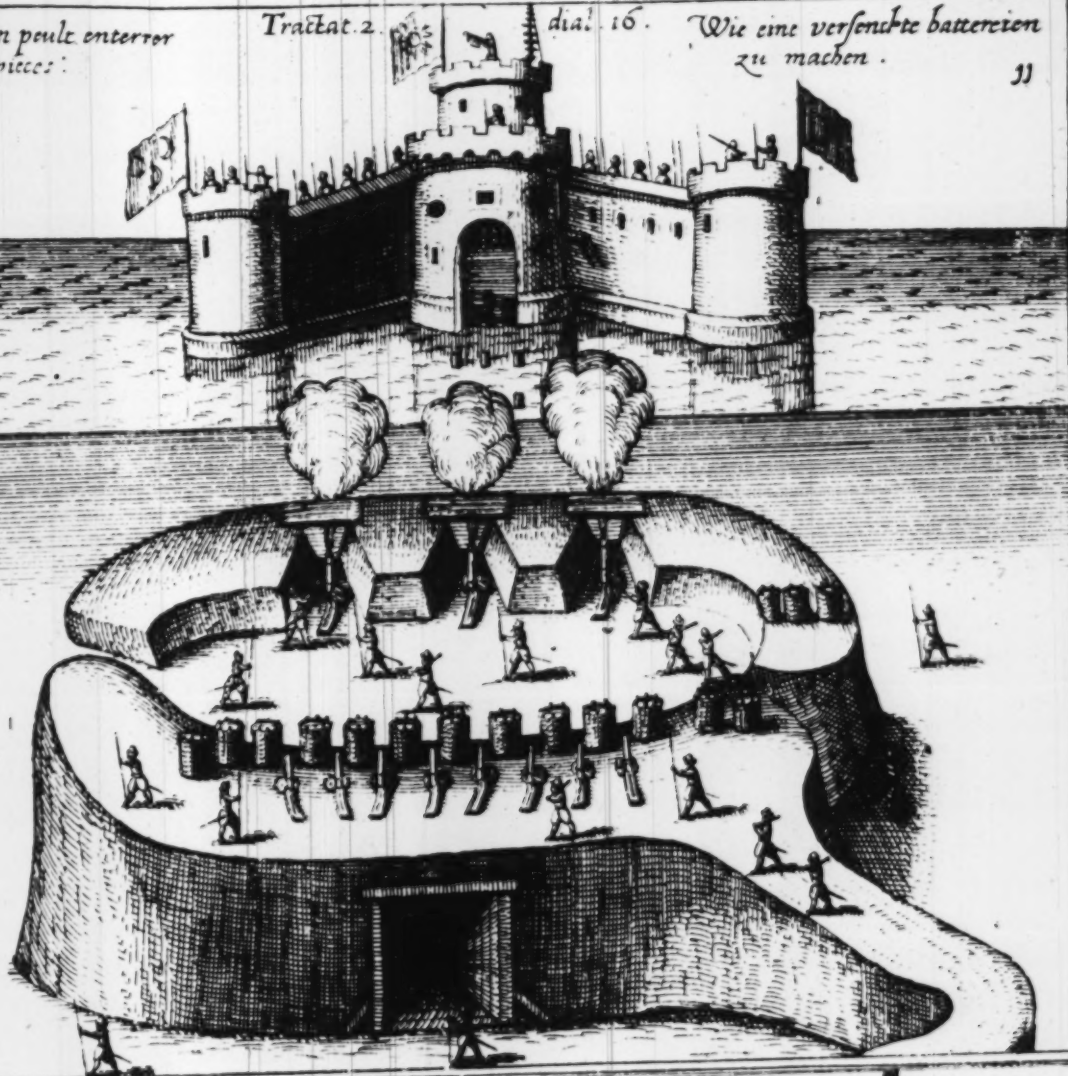
Comment on peut enterrer  
quelques piéces :

Tractat. 2.

dial. 16.

Wie eine versenkte batterien  
zu machen.

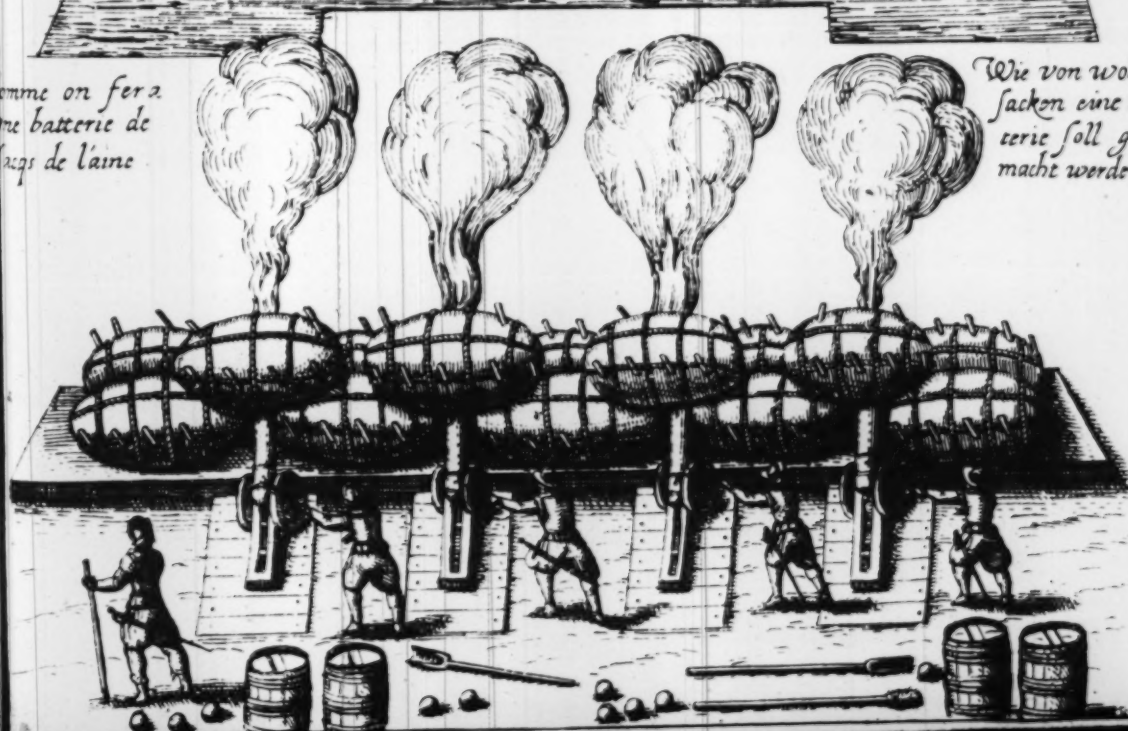
11



Tract. 2. dial. 15.

omme on fera  
une batterie de  
sacs de laine

Wie von woll:  
sacken eine bat:  
terie soll ge:  
mache werden.





CHAP. LXV.

*How wanting all other meanes, to make a Batterie  
by Woolfacks.*



Here none other but grauelly earth is to be had, thereto auoyde the shottering, that the *Enemies* Ordnance may make by the stones, to endanger the Camp, Woolfacks, may make the Sholders and *Troniers* in such manner, as this figure 11 is represented. This is no new inuention, for it hath long bene vsed by diuers Nations: now it were necessary that these Sacks were 17 foote long, and 7 foote thick: And to resist the Cannon, there should be three in breadth to make the Sholders or Parapets of the *Troniers*, and for the Demy-Cannon 2 and a halfe: And it is to bee vnderstood, that the two outmost of the three Sacks, must be somewhat shorter then that within, to giue sufficient ouerture for the *Troniers* without, that the blowing of the Peecces endamage them not, vpon the said ouerture 1 or 2 Woolfacks should also be layde to serue in place of *Blinds*, for the trauerfing and manning them the more safely: if by chance the Sacks doe any where take fire, there must be water and earth ready to quench the same, and to fasten these *Woolfacks*, they must be Pyled with Pyles driuen into ground, all firmly bound together. Also if other Ordnance then the *Cannon* or *Demie*, there must be as many more Sacks of Wooll for sholder defences, as that all the Peecces may bee well covered: as the vndermost of the 11 figure next manifesteth.

CHAP. LXVI.

*How to place great Ordnance, both to dismount the Enemies  
Artillerie, as also how to make a Batterie on the  
Curtin of the Place, and when.*



Although it hath bene a receiued opinion, that such Peecces as doe lye high on the walls, are in lesse danger, and haue more aduantage then such as are alowe in the Champion plane, because those aloft may more easily discouer those alowe then the contrary. Yet it is found otherwise by experience, as in the 9 figure is seen, wher the Peecces alowe, playing alwayes vnder the Peecces, aloft, doe and may well embouch them, or else not faile to cloy their Plat-formes, or beate their Cariages Wheels and Axeltrees, and so consequently make them vserviceable, besides that if they take them

T :

vnder-



vnderneath, they often dismount those aloft, whereas those aloft cannot dismount those alow, for if a Shot should light vpon the vpper part of the Mettall of a Peece lying vnder it, it will but glance away with little danger of dismounting, whereas if a Shot light vnder a Peece from alow, it either dangereth the dismounting thereof, or else the tearing of some part of her Carriage or Wheelles.

Now for that the charge of making Batteries is great, it requireth good husbandry should be therein vsed, and the cost not vainely spent, for thereby will accrue encouragement to the Enemy, and discouragement to the party. Besides, therein the Scyte and position of the place besieged, is to be well considered before it can be resolved, which is the best way, either to beleaguer or place the Battery thereunto: For a Place may be assaulted in one place, and yet battered in another, and sometimes the Batteries are to be made vpon the poynt of the Bulwarkes, and sometimes vpon the Curtins, euer ayiming at victory, the end of the enterprize vnderaken. To batter a place well manned, as Forts and Castles, at the Bulwarks and Canall-rates is best, being places of defence: But in a Towne hauing cloyed their Castellmats and defences, the Curtin is fittest to be battered, because it requireth more entrenchment, and is of lesse force in the Terraplenes thereof. *Orleans* and *Tromont* were battered vpon the Bulwarkes, and *Cors* and *Cambray* were battered vpon the Curtins, and so each gotten, wherein the best opportunity, and way is to be taken, to obtaine the descigne. And for battering a place vpon the Curtin, 18 Peeces will be necessary, namely 8 Cannon, 6 Culuerings, and 4 Demy-Culuerings, placed as in the figure 9 and is shewed, wherein the 8 Cannon playing at right angles, they are to shake and batter, by reason of the waight of their Shot, the Culuering play trauersely, and to cut out that which the Cannons haue battered, and the Demy-Culuerings to play vpon the Flankers and defences, as also to hinder the Sallyes of the besieged, and discover and dismount their Ordnance. The distance that a Battery for either should be made, ought not to be about 120 paces, or 150 at the most, or at 80 or 90 paces if possible, the lesse the better, yea though it were at the edge of the Dyke, for the neerer they are, the greater are their forces: so as the Ordnance may be couert, that the Gunners and Matrosses may be without danger of Musket shot, which is best at 80 or 100 paces, if you may conueniently approach so neere.

Take this by the way into remembrance for a note: That a Cannon at 120 paces, will pierce a wall or Rampart meanelly setled 15 or 16 foote, and being well setled onely 10 or 12 foote, but in close sandy ground 20 or 24 foote deepe. And that a Cannon may being well fortified, and duly and discretly manniaged, be discharged 100 times in one day.

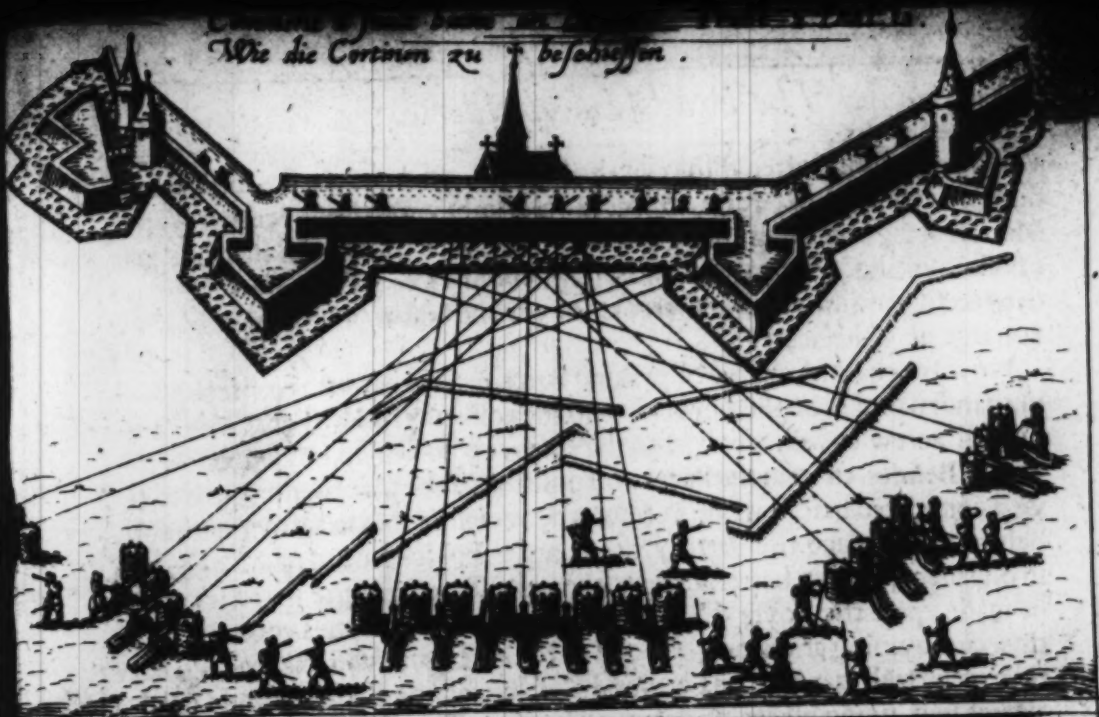
Note also that a Cannon with one shot made well and orderly, will ruine more then 100 Hods of earth can repaire: For one man can carie but 100 Hods of earth in an houre, the distance of 130 steps, or not much more.

Further, you may note that 1000 Shot succinly made out of 10 Cannons, will ruine more then 1500 Shot can doe, being made out of 5 Cannons: And lesse can the Enemy repaire the first, then the last: For a Cannon Shot made euery eight part of an houre at 100 paces distance, will make as much ruine as 12 men, can keepe in repaire.

But

But

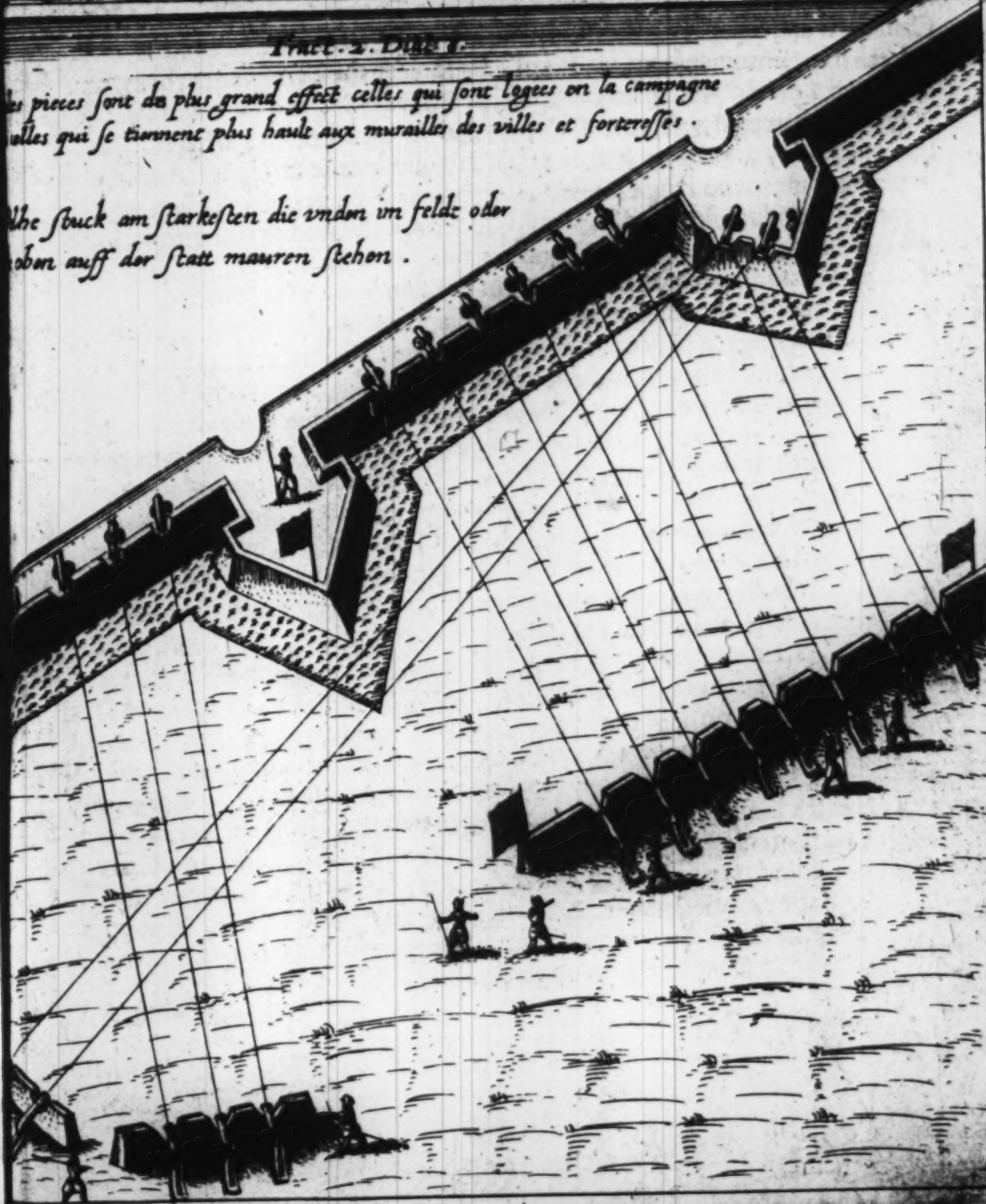
Wie die Cortinen zu beschießen.



Tract. 2. Ditt. 1.

les pieces sont de plus grand effect celles qui sont logees en la campagne  
celles qui se tiennent plus hault aux murailles des villes et fortresses.

Die Stück am starcksten die vnder im feldt oder  
oben auff der statt mauren stehen.





vnderneath, they often dismount those aloft, whereas those aloft cannot dismount those alow, for if a Shott should light vpon the vpper part of the Mettall of a Peece lying vnder it, it will but glance away with little danger of dismounting, whereas if a Shott light vnder a Peece from alow, it either dangereth the dismounting thereof, or else the tearing of some part of her Carriage or Wheels.

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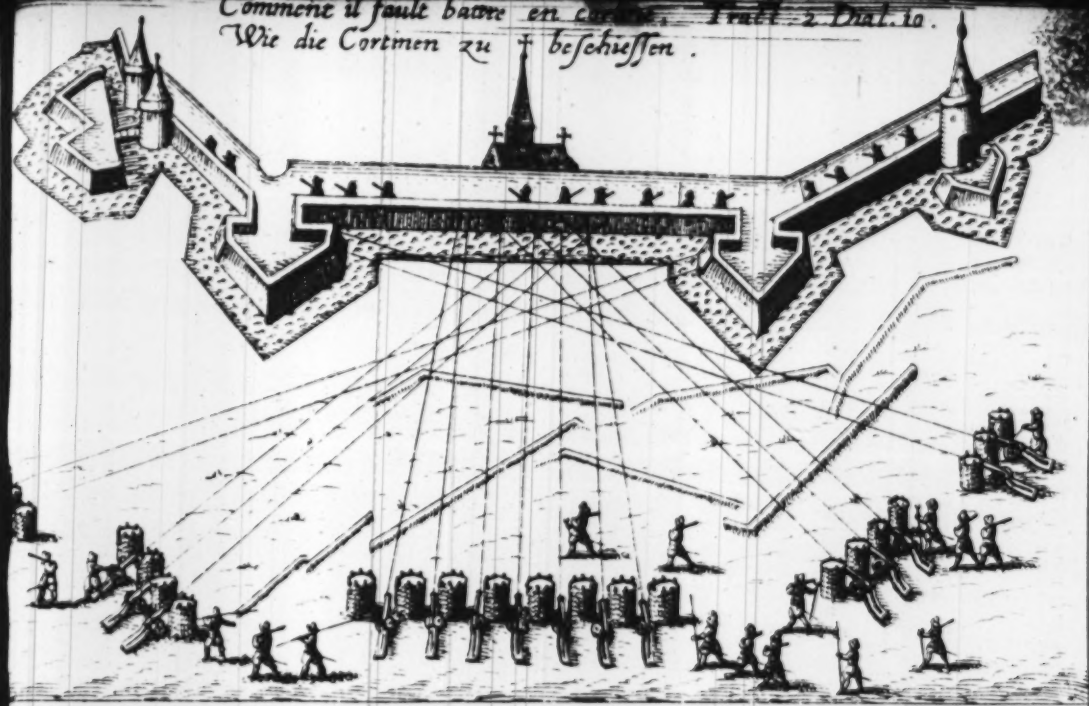
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But



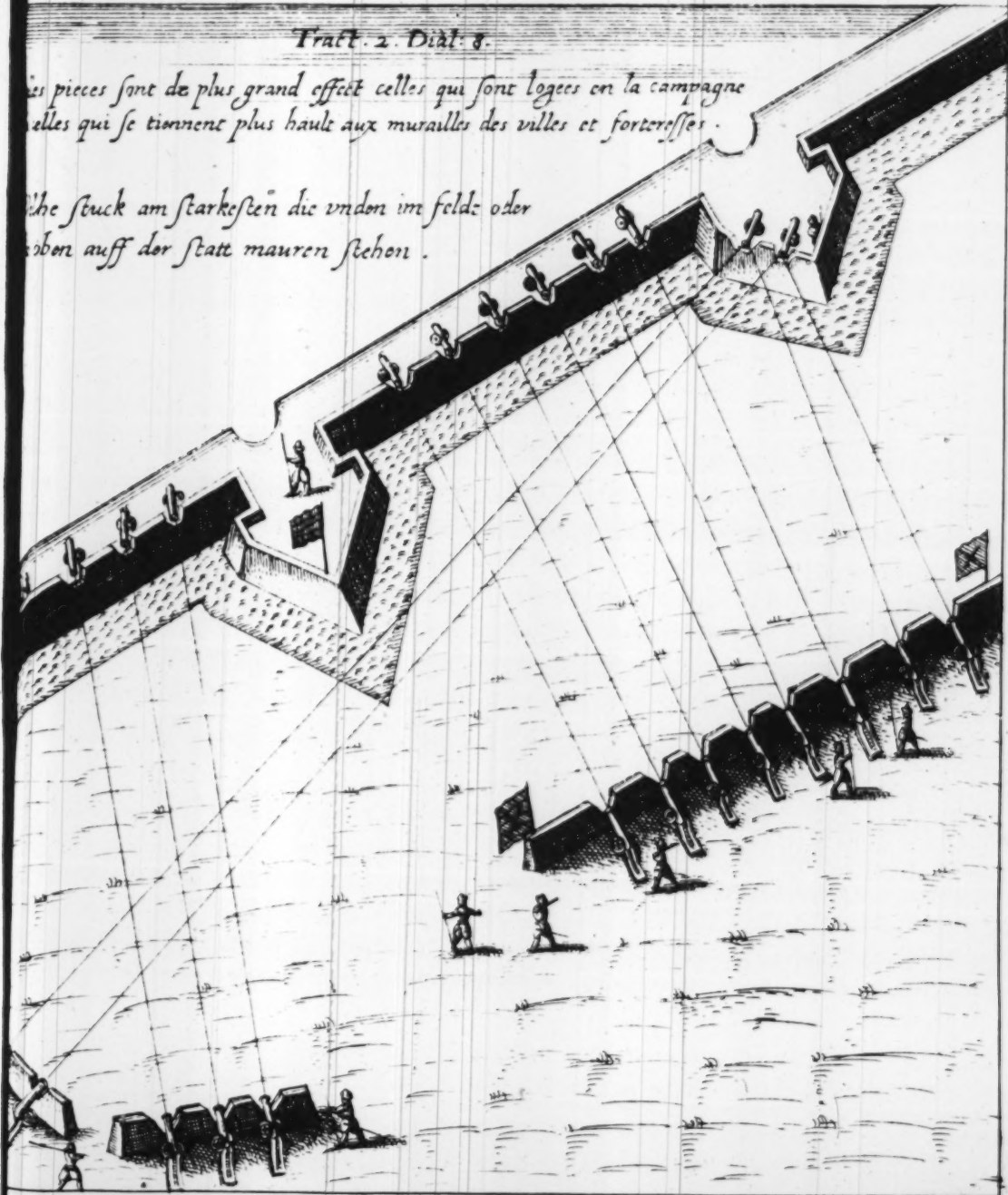
Commence il fault battre en carreaux. Tract. 2. Dial. 10.  
Wie die Cortinen zu beschuessen.



Tract. 2. Dial. 8.

Les pieces sont de plus grand effect celles qui sont logees en la campagne  
celles qui se tiennent plus hault aux murailles des villes et forteresses.

Die stuck am starckesten die vndon im feld: oder  
oben auff der statt mauren stehen.





But if 12 Cannons be well imployed in a Battery together the 96 Shott, that they may make in one houre, will ruine farre more then 144 men can keepe in repaire.

For 14 Cannons will ruine more then 12. and 16 more, then 14 spending, but the like quantity of Powder and Shot. Therefore Ramparts ought to be augmented in thicknesse, according to the Batteries made, but not in proportion, because the inner part of a Rampart suffereth not so much, nor is it so easily ruined, as the fore-part thereof may be.

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### CHAP. LXVII.

*How and when to make a Battery vpon the poynt of a Bulwarke,  
and of the defences to be made therein.*



When and where the Curtins are short and close, the Battery is to bee made vpon the point of the Bulwarke and *Canale-ries*: But then it requirerh as many or rather more Ordnance then before for the Battery of the Curtin was appointed. The 8 Cannon to beat about the point of the Bulwarke, the sixe Culuering trauerfing more at right angles with the Front thereof, and the foure or sixe Demy-culuerings to play vpon the Cassamats, on each side 2 or 3, and they are also to attend other occasions that shall happen, as hath already beene said, and as the figure 12 at 2 representeth together, with such retrenchments and defences, as the besieged may or should make, being forced, of which there is no danger when the Battery is made in the Curtin, wherein the Breach being once made, it may bee more easily forced without any other dangers then those of the Bulwarke and Cassamats, which are not onely farre off, but also to bee cloyed or dismounted afore-hand, or else they are opposed and encountred with the Demy-culuerings, and other Peeces placed on the brinke of the Dyke, especially where necessity will vrge, or occasion require, whereas in the Curtins there can hardly any such retrenchments bee made, as in the Necks of Bulwarks, where with halfe Moones, in the neck thereof, they may make new resistances with a few men, the Bulwarke being Myned, and the Towne imagined to be gained, yea when fire shall bee giuen to the Trayne, which may be perchance preuented also by countermynes, which cannot be so directly directed on the breach of a Curtin, as on the Bulwarke whose necke is narrow, and may soone be defended, and retrenched with lesse labour, time, and force, and cause the assaylants to present more men in danger of blowing them vp by the Enemies Mynes.



## CHAP. LXVIII.

*How the Ordnance are to be placed at the houre of ioyning of two Armies, to offend the Enemie most.*

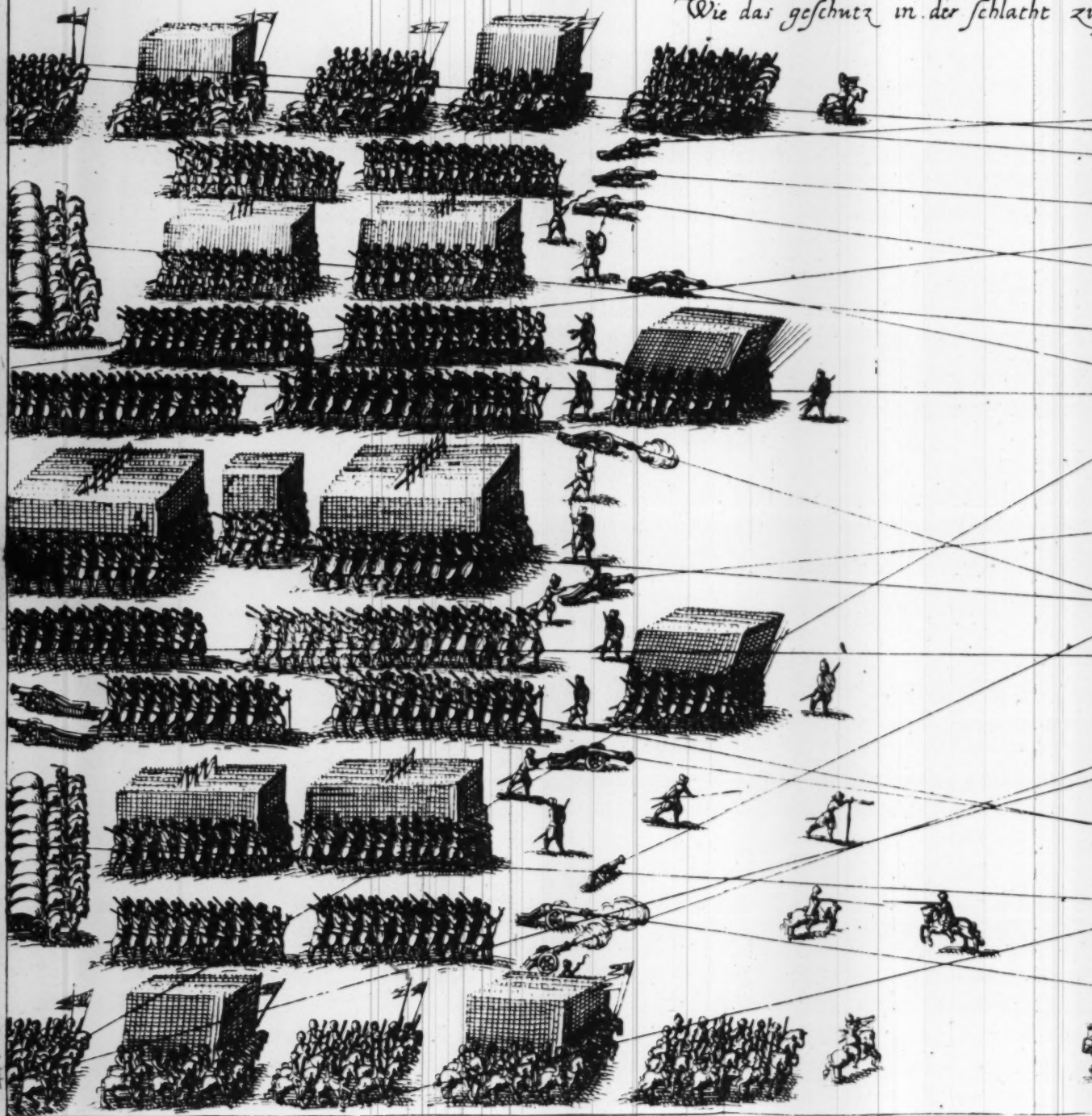


His is a poynt hard to be handled by me that haue not scene many Armies meete; but finding seuerall opinions deliuered by others, I haue thought fit to recite them, & deliuer what to me seemes most reasonable, leauing each to chuse either of them, or any other way as to him shall seeme most fitting. Some say that the Field Peeces should be placed in the Front of the Bands, and some that they should be placed trauerfly two and two, or three and three together, on the sides or flanks in the forme of the *Muskettiers*, couered with the wings of the Horsemen. But it seemes to mee most expedient, that certaine Peeces should be placed in the Front, which may endamage the Enemie on all sides, seeking alwayes the places of most aduantage, without danger of loosing any of their Ordnance, and certaine Peeces also to be placed in the Flanke, some to shoote forth-right, and some a Trauers, each 3, from other distance 50 or 100 paces. And then there is no more danger but in the ioyning to withdraw the Ordnance, that our Ordnance hurt not our owne bands. And that they be alwayes ready to be Trauersed, and retreated, as neede shall require, which may much conduce to victory: But it will seldome happen, that in a Battaile there be such places so commodious to be found as were to be wished, for that most commonly we shall be constrained to conforme our selues, according to the present occasions, as woods, hills, and other vneuen places, for which no other rule can be giuen, but with great iudgement to seeke how to get the aduantage of the Enemie, without being offended by Sunne, winde, or dust, and such like, which though they may be thought to be small things, yet they will bee therein found to be of great importance. But I cannot be of their opinion to haue all the Peeces on the sides to be best, for so the Squadrons meeting, ours shall be more offended thereby then the Enemies, besides, that thereby this great danger will arise, that when the wings of our Horsemen would be willing to aduance speedily, they will be greatly troubled with those Peeces so shot out of the sides: wherefore the Generall, or Master of the Ordnance, or his Lieutenant, considering these things, must giue directions how the Ordnance shall be lodged, either all in Front, all in Flanke, or some in both.



Tract. 2.

Comment il faut loger l'artillerie au p  
Wie das geschütz in der schlacht zu

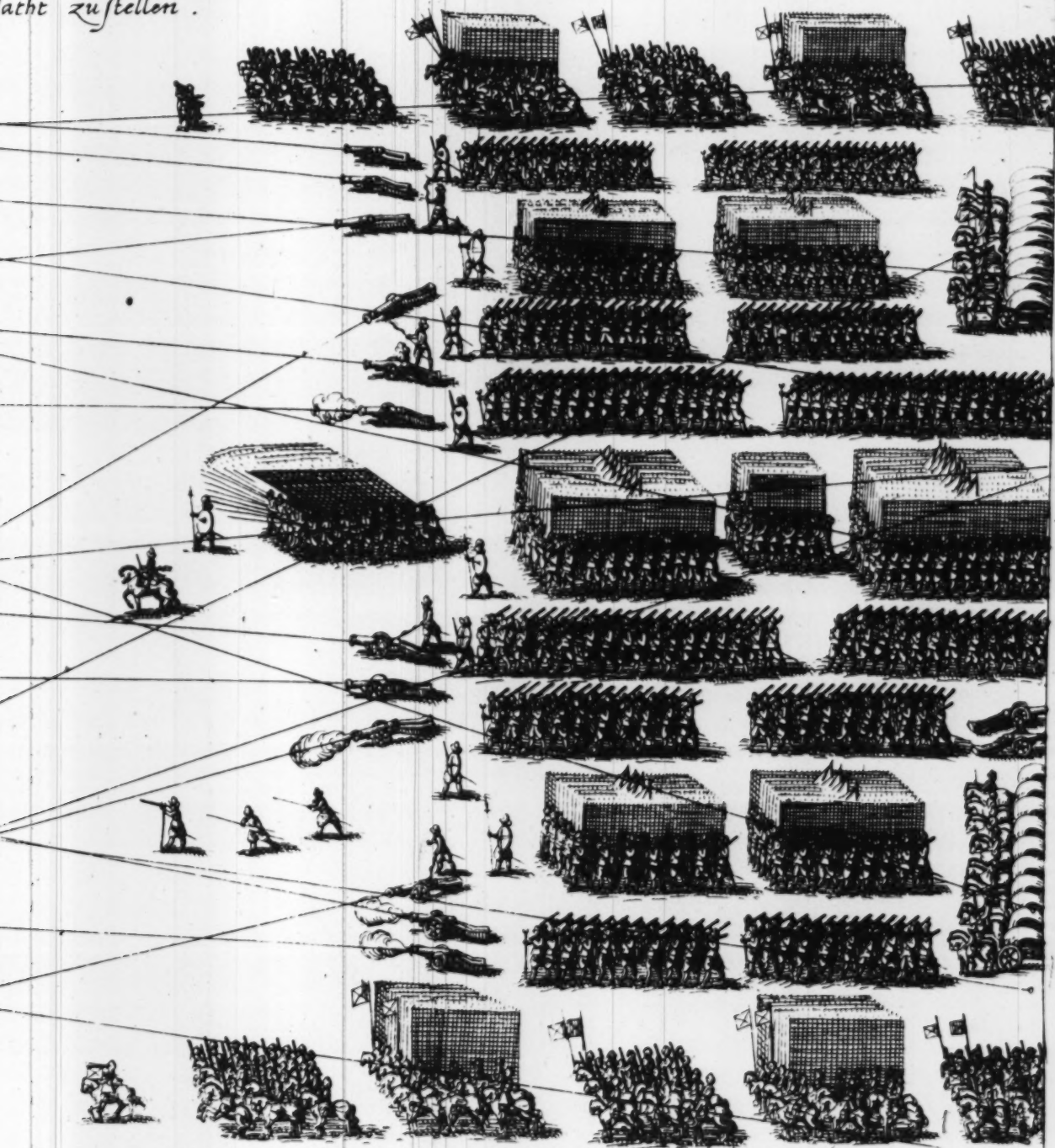




ie au point du Combatt.  
acht zu stellen.

Dial. 5.

8





## CHAP. LXIX.

*How to fill vp a wet Dyke, whereby to approach  
the Breach made.*

**H**aving already shewed how a Battery may in diuers sorts be made, and also how to make the Breaches sufficient for entery, we will now shew likewise, if the *Dyke* should be deepe, and full of water or mud (that the Souldiers are thereby hindered) how the same may best be filled vp. Wherefore, although there be many wayes to performe the same, yet this in my iudgement is the best; namely, that when a sufficient *Breach* is once made, that then the *Approaches* be also immediately made vnder the couertures of the *Trenches*, euen vnto the edge of the *Dyke*, and then with Faggots, and earth, or *Sausedges*, (whereof we haue sufficiently spoken already) to fill it vp, hauing the benefit of the ruines that the *Cannons* haue made of the *Wall*, and Faggots, and *Sausedges* which cannot be wanting, whereas either Gardens, Trees, or Woods are neere hand. Or else if great Trees be throwne into the *Dyke*, if they swimme, being of Firre or dry light wood they will, then Plankes layd vpon them (the *Dyke* being excessiue deepe) and on each side of such Floats, blinds being raised to hide the Passengers from sight of the *Flanker*, they may thereby passe to the foote of the *Breach*, euen as by a *Bridge*: But ouer a small Riuer or narrow *Dyke* a Bridge may be made ouer vpon a *Boates*, as in the 17 figure at  $\beta$  is represented. But being first well informed of the quality of the *Dyke*, whether it be of standing or running water: If it be standing water, then a dozen of light Float *Bridges* will helpe well; if there be any scarpe on the other side, or else they are worth nothing: But in sted of them *Floats* being made with two Fir poles or light wood strait about 15 or 20 foote long, about the thickness of a mans legge or thigh, vpon which two sides may be nailed crosse-wise ledges or boords of wood, about 3 foote long all along vpon them. And so these may each of them be caried by 6 men; namely 4 at the two ends, and 2 at the mid sides, as a corpe is vsually borne to be buried. And at both the ends of those two sides, there must ropes be fastned, by which these floating bridges shall be lanchd, and drawne from one side of the *Dyke* to the other, foure or fixe Souldiers being gotten vpon it, resting them vpon their Pykes, which being landed and passed ouer: the Souldiers on the other side may draw, bake the Float by the ropes at the end next them, and then 4 or fixe more may get vpon the same, and the Souldiers already landed, may draw them ouer by the ropes at their end, and so helping one another from side to side, many men in a little space of time will be transported ouer. And when as there are a competent number gotten, or the Floats drawne vp, may serue for scaling Ladders, or to mount the Breach the better by. But if for the walls these Ladders or Floats be too short, there may at one end of each side be two hoops of Iron fastned, and so firmly fitted, that the two other ends of another Float or Ladder may fitly enter therinto, and so two or



moer shall make one Ladder, vntill they be found of sufficient length. And lastly, we will remember you of Ladders, of Cords, or Ropes, with wooden steps like entering Poole Ladders in Shippes, hauing an yron Grapnell to throw ouer the wall, to hold fast on the Vawne or Paraper.

## CHAP. LXX.

*Of the Gunners seruice in generall.*

Now forasmuch as Ordnance are Engins of force, reason, waight, and measure: and the Gunners men exercised and experienced in them, and their apurtenances in making plat-formes, with defences, *Troniers*, *Gabbions*, *Loopes*, *Parapets* of earth, and *Faggots* about 23 or 24 foote high, of *Faggots* 2 foote high of earth, bed vpon bed vnto eleauen foote high, and after 3 foote of *Teraplene*, to raise the *Troniers* and *Loopes*, so that for the *Cannon* it be 3 foote wide in the Barbe within, and 12 foote wide without, the lower part thereof to descend scarpwise, the better to discouer the *Enemies* auenewes, and offend them the more freely, for auoyding the blast, and smoake, and ruine, it would else make: For the *Culuerings* 2 foote and a halfe within, and 9 foote without will suffice; and for lesse Peeces, lesse measures. If the Battery be to be made with *Gabbions*, they being filled with earth without stones, moystened and rammed 7 foote a peece in dya-metre, 3 rankes betweene each 2 peeces, if the place will permit, or 2 at the least, and 3 rowes also one before another, setting one betweene two; so if the first ranke haue 3, the second will haue 2, and the third one: But it will be hard to make a safe Battery with *Gabbions*, *Cannon*, or *Culuering* prooffe: And each plat-forme is to haue 30 foote for the reuerse of the *Cannon*, and 27 foote for the *Demy-Cannon*, he ought to see that it bee leuelled, or rising 1 foote for 20 backwards, the better to stay the reuerse & facillite, the bringing the Peece being loaded to the Loope: He ought to seatch and examine the goodnes of the Peeces, their *Ladles*, *Rammers*, *Spunges*, and *Tampions*, *finesse*, and roundnesse of the Shot, force and goodnesse of the Powder and Match: And to see all fitted accordingly, and to place the Powder couertly, hid safe from the fire of his owne, as also of the *Enemies* Ordnance. To see the Gunners take their marks towards the vnder part, giuing each vnder Gunner his charge.

In Plat-formes, the first plank next the Barbe should be 9 foot long: the second 9 and a halfe; the third 10, &c. euery planke encreasing halfe a foote, to spread for the Reuerse, as may be scene at the first figure at *a*.

CHAP. LXXI.

Of the differences of our English measures in Feete and Inches, from the Measures of other Nations. And also of the difference of pounds and hundreds.



Almost all Countries agree in this, that 12 inches make a foote, but the length of their severall inches doe commonly so much differ from one another, as whatsoever they speake or write of Measures in feete and inches, must not without reducement bee vnderstood, to agree with our English foote and inch of Assize, as the discourse and Table following will make plaine, whereby it will appeare how little Forraigne translations, without diligent and exact reduction, when they discourse of paces, yards, feete, inches, or other measures, write they neuer so well and truly of their owne, can availe vs.

For three inches at *Vienna* is 3 and  $\frac{2}{10}$  of our English inches.

And 3 inches at *Venice* containeth  $3\frac{1}{10}$  of English inches.

Two *Grecian* inches is 3 English, they hauing 8 inches in our foote, so their foote is equall with the English foote of Assize.

The foote in *Banaria* wanteth  $\frac{1}{4}$  of our inch of the English foote.

The foote of *Antwerpe* is  $\frac{4}{10}$  of our inch, shorter then the English foote.

The foote of *Farara* is  $15\frac{2}{3}$  of our English inches.

The French foote de Roy is one foote and  $\frac{1}{10}$  of an inch English.

The Tuscan Brase is 23 English inches.

The Florentine Brase is 22 and a halfe of English inches.

The Bresian Brase is  $17\frac{2}{3}$  of English inches.

The Canne of Naples make 20 English inches.

The Canne of Rome make 22 English inches.

The Millan Brase make 23 English inches.

The Lorraine foote is  $11\frac{2}{3}$  of our English inches.

Whereby each man may iudge how much confusion would haue growne to the Reader, that should haue read a French, Italian, Germane, or Spanish Author, and had no meanes to vnderstand that there were any difference in length of the Measures of one same name. And the like may be said of the waights vsed of severall Nations, which with the former of Measures, would not onely haue a double error, dangerous for practise, but also confounded the Readers that suspected no such thing.

The pound Troy being about 1 ounce and a halfe lighter then the pound Auerdepoyze, yet the ounce Troy being heatier then the ounce Auerdepoyze, because Troy hath but 12 ounces, whereas Auerdepoyze hath 16 ounces in the pound. The Kintall of *Biscay* 150 l. is but 124 l. English. And the great Kintall of *Portingall* 128 l. English, the lesser Kintall is 112 l. English.

The hundred subtrill or small hundred, is 100 l.

The great hundred is 112 l.

One pound *Troy* waight is 13 ounces 4 *d.* waight, 19 *gr.*  $\frac{1}{2}$ , of a graine of the *Hauerdepoize* waight. By these are all their Ordnance and Munition waighed. But in seuerall Countries they differ, as you may see in *M. Records* booke of Arithmatick, called *The Ground of Arts*, whereby the Reader may iudge how necessary these differences are to be knowne, and that reduction should be duly made least confusion follow.

## CHAP. LXXII.

*Of the making of Salpeter, whether it be  
Naturall or Artificiall.*



*Salpetre* is a body of *Ayre*, transformed into *Earth*, apt by *Moysture* to be dissolued, and by *Fire* to be resolued vnto his first state *Ayre*, being an *Ayrie* substance, fixed in dry *Earth*, dissolued by *Water*, and concocted by *Heat* into a solid substance, and accepted the rich *Mine* of *Princes* in this Warlike Age, and by *Philosophers* accounted a quintessence of *Qualities*, participating of all, and yet simply no one of them: For being sharpe and salt, in *Taste* hote and dry, it enioyeth the quality of *Fire*, and being also hote and moyst, easily dissolued into *Water*, and by fire resolued into *Ayre*, appeareth to be *Ayre* it selfe: And being whire and cleare cooleth warme *Wine* in hote weather, being dissolued, and a vessel therewith put therein, it approacheth neere *Water*, colde and moyst: And being, it will bruse, and be brought, or be molten into a hard stone: it is also colde and dry of the quality of the *Earth*, enioying all the qualities, and a conuertible to all the *Elements*. It so becommeth as they say a *quinta essentia*. *Salpetre* is of two sorts namely, *Artificiall* and *Naturall*. The *Naturall Salpetre* is that which groweth in continued *Mynes* of the *Earth*, or vpon *Rockes*, or in *Vaults*, on *Walls*, and by *Natures* worke becommeth perfect *Salpetre*, whereof the store is to small too depend vpon. The *Artificiall Salpetre* (though naturally growing) also requireth the helpe of *Art* to bring it into true and perfect *Petre*, and is found in so many places, as in *Loame-Floores*, *Mud-walls*, *Sellers*, *Doue coates*, *Stales*, *Stables*, and such like places, whereas the rayne cannot come to dissolue, nor the *Sunne* to dissolue the *Ayre*, substance, fixing and growing therein, that with labour and industry with *Arts* helpe, to cause abundant procreation, sufficient store may be provided, and Artificially made thereby in this manner. First, for choyse of the *Earth* for finding, it whether sufficient quantity of *Petre* be therein or not, obserue this, Pare the *Floores*, and digge 3 or 4 inches deepe therein: if you finde the *Earth* full of white and yellow specks, and that hauing put a little thereof vpon the top of your tongue: if it yeeld an *Ayrie* biting, or sharpe tindge thereon, the *Earth* is good, and will be rich, and yeeld store, according to the more biting or tindging taste thereof. Then digge that *Floore* so deepe, as you finde



finde the Earth to be good, which in some places will be a yard, and in others not a foore deepe, vnder the vpper Floore make the Earth somewhat small: And put it into halfe Tubs loose, hauing a Taphole in the bottome of each, which stop with a staffe and couer, with a wilpe, that the Earth runne not out, when the liquor drayneth. Then fill the said halfe Tubbs with water a handfull higher then the Earth, and so let it stand in soke 24 houres, and then draw out the staffe or pegge a little, that the water may drop and drayne out thereby into another halfe Tub that must be set vnder it of purpose to receiue the liquor, which Liquor keepe, and lay the Earth vpon the Floore, which in six or seauen yeares will againe breed as much more Petre therein, and in some floores, especially with helpe, in farre lesse space. When you haue collected a sufficient quantity of such Salpetre liquor (vnlesse you haue Mother liquor) you must of some of it make the Mothers thus, boyle your Salpetre liquor in a Caldron, and scumme it (which scumme reserue) vntill the liquor being proued with a knife, be found ready to congeale; then take off, or else put 8 or 9 times as much Salpetre liquor thereunto, and hauing made the scum rise, and taken it off, and reserue it, let it boyle a fret, vntill the liquor be againe able to congeale: which if it prooue too tender, it is a signe it is not boyled enough; and if it be too hard, then that it is burnt too much: and must for the first be more boyled, and for the latter recovered with more Salpetre liquor, and renew the Worke: but being found indifferently betweene both, take it from the fire, and put it into halfe Tubs, wherein good wood ashes are placed vpon a laying of Strawe vpon faggot stick, or Lashes in the bottome thereof, and let the liquor drayne through the same, and put it into coolers, or brasie shallow pannes to congeale, and let it stand in a coole roome, where in two or 3 dayes it will shoote out like yce sickles, and keepe that for Roch Petre, and the liquor that will not congeale, keepe for Mothers, to worke a new for more as before. And this is the order to make Artificiall Salpetre: And the scumme that rose in the boyling mixed with water, and sprinkled vpon Floores, will exceedingly procreate Salpetre in short time.

*To collect Salpetre that naturally breedes on Walls, on Canes, in the Ground, or in Vaults.*

**G**ather the Petre together, and adde thereto  $\frac{1}{2}$  of quick Lyme and ashes, and put them into a halfe Tub with a hole, to drayne out water, then put in warmed water, and let it so stand, vntill the Petre be dissolued; then let it drayne out at the hole by little and little, and filtre it if neede bee, if it come not cleare enough: and then boyle it vntill it will congeale as aforesaid.

*To Refine Salpetre wet.*

**T**Ake what quantity of Salpetre you please, and put the same into a cleane Caldron. and put thereto a little faire water, and boyle them together vntill it raise the scumme, which take off and keepe, and let it congeale and shoote in coolers, as at first it did, and what remains, boyle againe with more cleare water vntill it congeale.

*To know if Salpetre be well refined.*

**T**AKE of it, lay it on a boord, and put a coale to it, if it raise an Azure scum, it is yet greasie; if it leaue pearles, it is yet earthie: But if it burne into the boord, and leaue nothing but a blacke colour, and rise with a long flamed ventosity and exhalation, it is well refined.

*Of Gunpowder, and to make the usuall sorts thereof.*

**F**ORasmuch as Powder is the Base and foundation of all Fire-Engins, therefore I will shew his preparations. There are ordinarily three sorts of Powder made, whereof one serues for Birding and Fowling, which is quickest, being 7 or 8 of Petre, for one of coale and of Brimstone: The second for Muskets and Pistolls, called fine Powder, which is 5 or 6 of Petre for one of Coale and one of Brimstone. The third, called Ordnance Powder, is of 4 or 5 of Petre for one of Coale and sulpher: But for seruice, there is but two namely, Ordnance Powder, and fine Powder. There are infinite receipts for making of Powder, but most States haue enioyned a certaine proportion amongst themselues, although much different one from another: wherefore no certainty can bee herein generally concluded, but every man must practise for his experience: onely a word or two I will say thereof, namely, that before the Receipt assigned be compounded, it is requisite for making of good Powder, to refine the Petre, to purge the Sulpher, and to chuse good coales, made either of Hazle, Alder, Willow, or Birch, Wood without Barke or Knotts therein being well burned. And then to worke those three Materialls well together: for therein consisteth a greater difference of force, by the difference in working of them, then is credible without experience. It is to be wrought together by a Horse-Mill, or Water-Mill, or in a Mortar with Pestles, the Materialls kept moyst.

*The Compositions of Corne-Powder.*

**F**IVE pound of Salpetre, one pound of Coales, and one pound of Brimstone, five pound of Salpetre very well refined, as afore is shewed, 1 l. of Willow, or Alder Coales wel burned, and of Sulpher well purged 12 ounces: Or of sixe l. of Salpetre, Sulpher and Coale of each one l. Or of Salpetre 7 l. Sulpher prepared with Quicksiluer as wee haue also shewed before: Or Floores of Sulpher one pound, & coales of Hazle halfe a l. Or if you mingle as much quick Lyme in powder as Sulpher, you shall make powder that the moysture shall not impeach taking of fire. Now seeing that it will be to litle purpose to shew the Compositions, vnlesse we also shew the manner of making thereof, which though the varieties both in composing and making are many, tending all to one same end, we will therefore shew one reasonable way for small quantity. First, put your Composition into a brasen Morter, or of wood with a brasle bottome. And take also a brasle pestle, and beat it so well together for the space of sixe, seauen, or eight houres, that in cutting the same with a knife, there can none of the Materialls be discerned a part, but all well incorporated into one body, alwayes moystning the same with a litle cleare water, strong Vinegar, or Aqua-vitæ, so much that the coales dust not, and so litle, that the composition in working become not paste.

paste. But if you would haue your powder very subtile, moysten the same with the distilled water of the outer rynes of Oranges, and let your sulphur be cleare Sulphur vine which in the melting had  $\frac{1}{2}$  of Quicksilver put therein, and incorporated, finely beaten, and searfed with coales, quenched with cleare water, wherein quicklime hath bene slaked, and either let it stand to cleare, or else be filtered: and this moystning will make the cornes thereof become hard, and not yeeld to moysture sodainly. After the composition is thus well beaten and wrought together (the more the better) take a Syue with a Velome, or Parchment, or Leather bottome, made full of holes, of the bignesse you desire your cornes, and put the Receipt or composition therein, with 2 or 3 short Rowlers, a little moystning it, that the poussier or dust thereof flye not away. And sifting them vpon a long Rowler, ouer a halfe Tub, so will the short Rowlers driuing the composition through the holes, make the cornes come out round yet of seuerall syzes, which to bring to haue all the cornes of one bignesse, you must passe through seuerall sieues, as they vse to syze Hayeshott: So shall your Cornes of euery syze bee equall. And looke what in searcing and dusting rests vncorned, must bee seperated from the rest, and new moystned and beaten, and then againe sifted as before, whereof some dust called *Poussier*, will still remaine vncorned, which may serue excellent well to make Rockets with. And these cornes may be dried in the Sunne, or in a warme place, safe from fire. The powder being dried must be dusted againe to seperate the Poussier from the cornes. And to the end the powder become not moyst, it should be kept also in a dry warme place, Moysture and Age being both enemies to powder: Moysture, by making the Petre descend, or else vapour, whereby one end of a barrell of powder that hath stood long, will be better then the other, and Age by breaking the proportion and incorporating by the Petres growing and encrease, and by the coales corrupting together, with the Sulphurs decaying by age in quicknesse to take fire. And so both through moysture and also by Age powder will decay. Next it must be considered whether it be moyst or dry, or wholly, or but in part decayed, and so accordingly to vse reason, with diligence to renue the same.

*Seuerall wayes to know if Powder be decayed or no, whether by moysture or age, and are decayed in part.*

**I**T is the reall practick part of a *Gunner*, to know his powder, and whether it be decayed or not, by mutation or corruption. And there are especially three ready wayes to finde the same. The first, is by the sight; the second, by the feeling: and the third and surest is by firing it. By sight if it be not blacke and darke, but bright, and enclining to a tawny blewish colour. By feeling, grasping it in the fist, if it runne through the fingers quickly, and auoydeth the handling, and cling not together. By fire, if fired it rise quick, and spread in a moment, smoake little, but riseth in a cleare flash, vnto which adde further, if it leaue no feces but carrie all away, the powder is good, or else the contrary is to be iudged.



*To renewe or renew powder, which is in part thereof.*

**O**Ften times in Forts, but vsually at Sea, powder cannot be kept so farre from humid vapours, but that it decayeth the same, and maketh it of little, and sometimes of no vse without renewing it. And sometimes it may decay by age as we haue said. Let therefore the Gunner first proue the powder by fire, and if it make a flame with a long rayle, that is, if it sleepe in its burning more or lesse, then for euery 100 l. adde 4 l. or 6 l. as need requires of refined Salpêtre thereunto, mixing them well together, and put them to be beat and wrought by the space of 3 houres together, and then moysting, corning, and drying the same as aforesaid, prouing it in meale dried, how it will rise by firing: and so doing, the powder may be made seruiceable, if the coale be not corrupted.

*Another prooffe of powder to be renewed, decayed in part.*

**T**AKE a pynt, or quart, or any other measure of good powder proued and dried well: Then take of decayed powder well dried the like measure, and waigh them both, and looke how much the equall measure of good powder waighed more then the decayed powder, adde so much Salpêtre refined, as the difference of their waights was vnto euery time, so much of the decayed powder, and moysten, beate corne, and dry it aforesaid, and it may being proued, be found seruiceable and good powder: for the Salpêtre onely wasteth by dissolution, which neither the coale nor brimston doth, wherefore by the rule of 3, you may finde how much Petre any assigned quantity of decayed powder, will require to renew the same.

*To renew powder totally decayed.*

**B**Ut if the powder bee wholly decayed, lay a Raylin frayle or Matt in a bottome topped, bucking Tubb vpon Fagots or Lath, set on edge, to keepe the Matt from the bottome, and put in straw, layed crosse-wise, vpon which powre the decayed powder, then warme water and put thereon, and let it stand and soke 10 or 12 houres, thit all the Salpêtre may be assuredly dissolued, then let out the liquor at the bottome top, which filter and congeale into Petre, and adde thereto a due proportion of coales and Sulpher, and make it into powder as is formerly taught: For the coales and Sulpher dissoluing, will remaine behinde in the Straw, Frayle, or Matt: Or else if you put the decayed powder in a bagge, and boyle, or soke it in warme water, the Petre will soke out, but some will bee foked into the cloath of the bagge, and with more labour must be foked out.

*Another manner to renew powder without new making it.*

**T**AKE 3 l. of the decayed powder, and diuide it into 3 equall parts, which spread thinne vpon 3 Tables or smooth boords. Then dissolue one ounce of refined Salpêtre in a little warme water by it selfe, and with a hayre ouersprinkle it vpon one of the third parts. Likewise dissolue 2 c, and sprinkle it vpon one other of the third parts. And lastly, so dissolue 3 ounces of Salpêtre, and sprinkle vpon the third part of the 3 l. of decayed powder. Then dry the said 3 parts or pounds of powder seuerally, and proue by fire whether

ther that which had 1  $\mathcal{Z}$ , or that which had 3  $\mathcal{Z}$ . of Salpetre sprinkled vpon it is best, you may thereby know how much Salpetre will renew all the whole quantity of decayed powder in the same manner, without new making the same.

*To make powder that shall not decay with time.*

**T**ake what quantity of powder you will, and mixe it well with Aquavita, and make it vp in Balles, and dry them well in the Sunne, or in a warme place, and keepe them in an earthen pot well glazed, vntill you haue cause to vse them. *Cataneo* saith, this powder will neither decay, nor waste by age.

CHAP. LXXIII.

*Of the making of ordinary and extraordinary Matches, to giue fire with vnto Ordnance, or Artificiall Fire-works, and such like.*



**T**ake Ropes made of Towe, about the bignesse of a Mans little finger, being twisted loosely, and Taw and beate them with a Maller vpon a stone, till they be soft and opening: Then put them into a Caldron full of strong Lee, made with ashes and quick Lyme, wherein also a quantity of Salpetre or Mothers being put, and when they haue boyled well; of the liquour of the Lee consumed. Then draw out the Match, and twist it harder while it is moyst, and afterward dry it vpon Lynes, but first draw them through a hole, as Wyre-drawers doe their Wyre to make it euen.

*To make extraordinary Match of Cotton, Yarne made Bobbin-wise, of a finger thickeesse.*

**T**ake as many threds of grosse Cotton yarne, that hath not taken Salt-water by transportation or other ill Accident, and worke them Bobbin-wise of a competent bignesse, and boyle them in Salpetre-water, and squeeze them, and rowle them on a Table, whereon Mealed-Petre, and Sulpher is spread, then draw them through the palme of your hand, and then dry them well.

*To make Match that will resist fire and water.*

**T**ake Salpetre refined one part Sulpher; part, and put them into a Pot with  $\frac{1}{2}$  part of Camphere mealed with the Sulpher, and one part of fine mealed quick Lyme, with so much Lynseed oyle, oyle of Petre, a little Vernish liquid, to temper them well together. Then take of Cotton bobbin March as bigge as your little finger, and put it into the mixture to soke ouer a fire, vntill it be well imbybed, and haue soaked vp the liquor. Then take

the Feces or remainder, and put them in the palme of your left hand, and with your right draw the Match through it twice or thrice, claspings close your fist, that the Match may receiue the substance of it therinto. Then dry it vpon a line, and keepe it for speciall vses, for Vaults, Mynes, and moyst weather.

*To make a very violent Match.*

**T**Ake two ounces of Powder, 4 z. of Petre, two ounces of Aquavitæ, dissolue them ouer fire, and put in your Cotton Match, to soke it vp: if you imbibe the Ficelles for your Rockets therein, it will bee very proper, you may rowle and rub them in Meale Powder vpon a Table, dry them and keepe them in a dry place, which let suffice at this time.



OF





OF  
ARTIFICIALL  
FIREWORKES  
FOR  
Tryumph and  
Service.



Although Gunpowder with the soule Petre, and the life Sulpher, and the body thereof Coale, be indeed, the chiefe bases and foundations vpon which the practise of Artillery, and making of all artificiall Fireworks, either for seruice in the Warres, or for Triumph after Victory, or for delight and pleasure dependeth, whereof wee haue already spoken sufficiently: yet Fire being the Primarie cause for performing their sequent effects, we will first briefly define what Fire is, and then shew who were the inuenters of it, according as Antiquity hath diuersly left vs their Testimonie. Fire is an element hot and dry, the most rare light and piercing, either detayned herebelow by Art, or constrained by Accident: It ingenders and feedes vpon that, which by Nature it alwayes affecteth and it strueth to get aloft, as vnto the naturall place and repose thereof, as our first Theorem plainly manifesteth.

The Poets fained, that *Promethius* first stole the Fire from Heauen: But *Vitruuius* saith, it was accidentally found, and happened by the violent agitation of the Windes and Tempest, among the Armes and Branches of Trees, robustly rubbing one against another, which made them kindle fire & burne. *Plynie* said, that it was found by Souldiers, because they vsually giue violent strokes vpon solid things, oft times striking sparkes of fire. *Lucretius* said, it was ingendred from the lightning, and that *Vulcan* the King of Egypt, was the first that perceiued that fire to make vse of it amongst humane creatures, wherefore the making of *Ioues* Thunderbolts was attributed to him. And *Or-*

the Feces or remainder, and put them in the palme of your left hand, and with your right draw the Match through it twice or thrice, clasping close your fist, that the Match may receiue the substance of it therinto. Then dry it vpon a line, and keepe it for speciall vses, for Vaults, Mynes, and moyst weather.

*To make a very violent Match.*

**T**Ake two ounces of Powder, 4z. of Petre, two ounces of Aquavitæ, dissolue them ouer fire, and put in your Cotton Match, to soake it vp: if you imbibe the Ficelles for your Rockets therein, it will bee very proper, you may rowle and rub them in Meale Powder vpon a Table, dry them and keepe them in a dry place, which let suffice at this time.



OF



OF  
ARTIFICIALL  
FIREWORKES  
FOR  
Tryumph and  
Service.



Lthoug Gunpowder with the soule Petre, and the life Sulpher, and the body thereof Coale, be indeed, the chiefe bases and foundations vpon which the practise of Artillery, and making of all artificiall Fireworks, either for seruice, in the Warres, or for Triumph after Victory, or for delight and pleasure dependeth, whereof wee haue already spoken sufficiently: yet Fire being the Primarie cause for performing their

sequent effects, we will first briefly define what Fire is, and then shew who were the inuenters of it, according as Antiquity hath diuersly left vs their Testimonie. Fire is an element hot and dry, the most rare light and piercing, either detayned here below by Art, or constrained by Accident: It ingenders and feedes vpon that, which by Nature it alwayes affecteth and it striveth to get aloft, as vnto the naturall place and repose thereof, as our first Theorem plainly manifesteth.

The Poets fained, that *Promethius* first stole the Fire from Heauen: But *Vitruuius* saith, it was accidentally found, and happened by the violent agitation of the Windes and Tempest, among the Armes and Branches of Trees, robustly rubbing one against another, which made them kindle fire & burne. *Plynje* said, that it was found by Souldiers, because they vsually giue violent strokes vpon solid things, oft times striking sparkes of fire. *Lucretius* said, it was ingendred from the lightning, and that *Vulcan* the King of Egypt, was the first that perceiued that fire to make vse of it amongst humane creatures, wherfore the making of *Ioues* Thunderbolts was attributed to him. And or-



*phens making little or no distinction betweene Vulcan and fire, in his Himne singeth.*

*Brave valiant Vulcans living flames on earth remaine as yet,  
where in bright shining fire Roabes his Maiestie doth sit, &c.*

Fire being also a thing necessary for mans life, consisting of heate and humidity, symbolizeth generation so neerely, that sage Antiquity therefore faigne the marriage betweene *Vulcan* and *Venus*, and attribute the cariage of Nuptiall Torches vnto him, at such times as the Louers would embrace each other. Many more were the ancient fictions & opinions concerning this Element of fire: but those I leaue for breuities sake, concluding it as I begun, Fire to be a more rare, subtle, and light element of Nature, then the ayre which is but his Nurse, seeing that if ayre become compact, and fixed in a straight place, and fire chance to burne such an Ayerie body, that would either eate or drinke, or consume it, and thereby leaue the place voyd, which nature abhorreth, as appeareth by our 4 or 5 *Theorems*, or else that rarifieth and encreaseth the body thereof by the third and 6 *Theorem*, and so 2 bodies should be in one place contraty to the 7 *Theorem* hereof; which let suffice, and so I will proceede to the matter, for contriuing and composing of some Fire-workes, both for Seruice and Triumph, and conclude this Treatise for this time.

### *Of Rockets and their structures.*



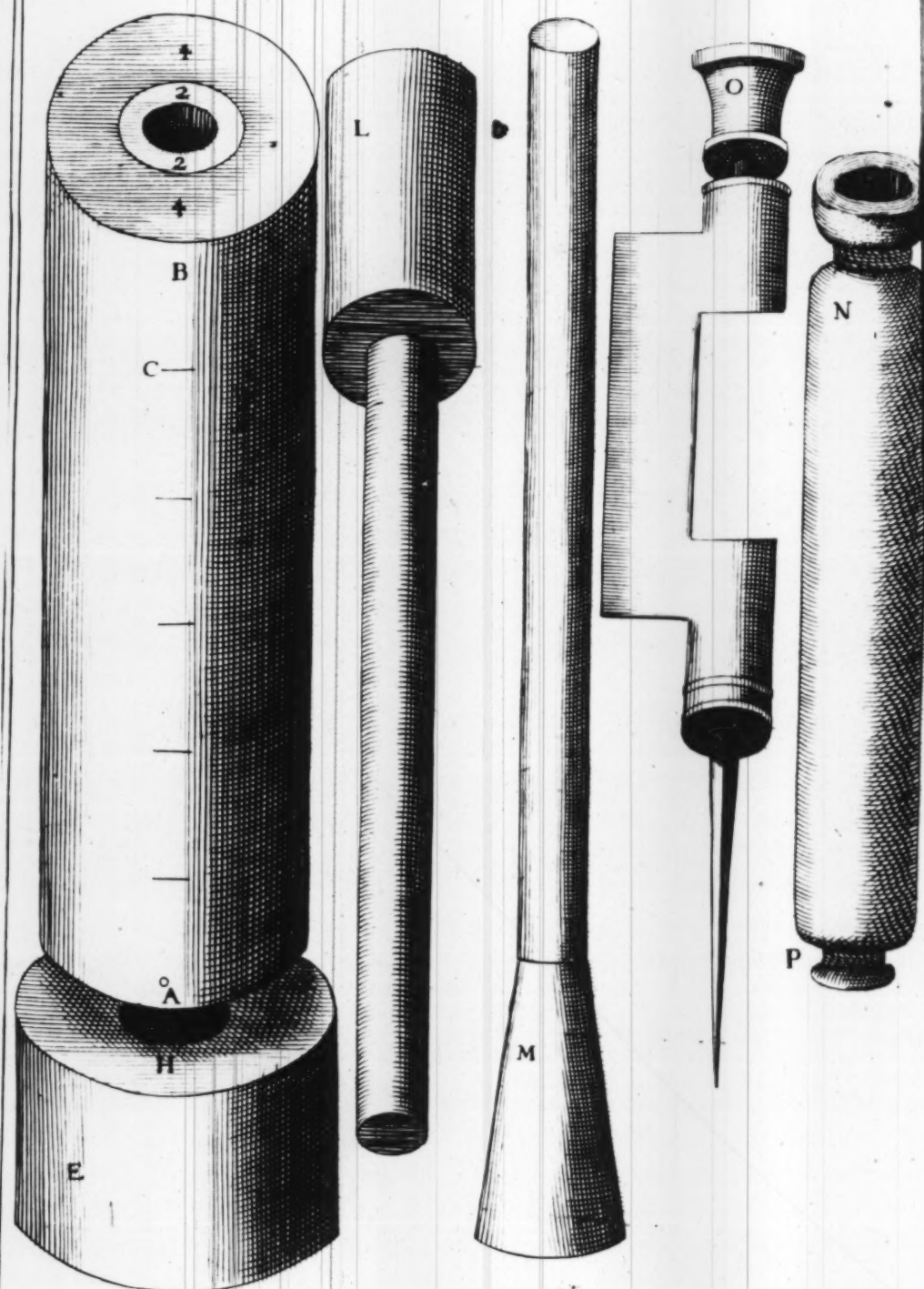
Having hitherto shewed the Gunner how to apply Artificial Fire-workes in the Warres, referring their severall composings hither, as also the manner of making Fire-workes for Triumphes and pleasure, wherein I will begin with the making of *Rockets* in the due construction and application, whereof consisteth all the pleasure of Motions of Fire-workes: For the making of *Rockets* there are many things necessary, as the Mould The Drifts, & paper or Parchment (for paper or Parchment *Rockets* double and well pasted, or glewed) Pryming Pearceers, Rodds, Morters, Searcers, Mallets, and diuers Receipts and Compositions of the Materials, wherewith they are loaded or made. Therefore it will not bee amisse to shew the reasons, formes, and proportions, as well of the Moulds for Paper and Parchment *Rockets*, as also the Mixture, Receipt, and Composition, whereof they and the Cane and bored *Rockets*, according to the tyze of their grandures, are to be made. First, vpon a Paper you should know how to trace or draw the figure of the Mould, according to the bignesse you would haue your Rocket, that your Turner may vnderstand how to make them. To doe which, make a right lyne vpon a paper, and take with your Compasses the breadth & height of the Rocket you intend to make, and with that distance, set sixe of them along in the said lyne, as from the point *A*, to the point *B*, with the Tayle and all, next the vent or mouth thereof, or rather 6 and of those



h  
1

B

Tract. 3. cap. 26. fig. 5.





those ouertures or heights. The wood of the Mould must be inuironed about the Soule, or concaue Cillinder thereof, & also as thick as it, in such sort, that the Calibre thereof be full 3 diametres. And the Soule or Concaue of the Paper to abate  $\frac{1}{2}$  in circumference for his thicknes, as may be seene in the 21 figure at *g*. So *AB* is the length of the Mould, and *BC* is the dyametre thereof. the figures of 4 shew the thicknesse of the wood on each side, and 2 the thicknesse of the paper. The foote shall haue the thicknesse or diametre of the Mould, and be at 1 and  $\frac{1}{2}$  thereof in height, with a head lessening to fit the vent, with a Pearcer, ioyned to the foote and body of the Mould, and is to bee screwed, or let in that with a doue taylor, that they may bee firmly fastened together, as *A* to *E*. The Drifts must bee of the full length of the Mould, and very little lower then the dyametre of the Soule of the Paper, the one represented at *L*, and the other at *M*, and that which is for the driving the powder, *M* must be the thicknesse of one rowling of paper lesse and longer then the other *L*, that is for the former to rowle the paper vpon, that it may enter in and goe out, to driue the powder and mixture close home, being filled by a little and little at once, and then driuen.

So then the Rocket *N* will be 10 Calibres, 9 for the powder, and 1 for the bindings aboue, & the bond and fucill below. And the Pearcer *O* must be at least  $\frac{1}{2}$  of the length of the Rocket, whereof by the figure you may see both the forme and proportion. And also although some would haue a pin reach so high from the breech of the Rocket, and of the Drifts fitted with a hollownesse to receiue it in the driving: yet that fashion being very vncertaine and requiring much skill, handinesse, and practised experience, to bring it to rise well, I haue rather left it to be pearced after the driving.

For the Receipts, they must be according to their grandures, & to be filled by a little and a little at once, and giuing 4 or 5 strokes vpon the Drift with a waighty Mallet, continuing so vntill it be full within a finger or twos breadth of the top, and it must bee made of strong paper or parchment well rowled about the Former, or else it will be worth nothing. and besides, if it be not also well pearced and pryed, it will neuer rise well. If the Receipt for small Rockets should be filled into great, the mixture would be too violent, for that experience teacheth that, fire being giuen to a composition in a large amplitude, and burning a great quantity, in a little space it holdeth not proportion with the little. For the Rockets of one or two ounces of Receipt, they may bee of the composition following. Either take fine or Harque-  
For one or 2 ounces Rockets.

buze powder one pound, and soft wood coales two ounces: or one pound of fine powder, and another pound of Cannon powder: or take one pound of fine powder, and an ounce of Salpetre, and 1  $\frac{1}{2}$  and a halfe of coale.  
 For Rockets of 4 z, and for Serpents in quills take 4 l. of powder, 1 l. of Salpetre, and 4  $\frac{1}{2}$  of coales, and sometimes  $\frac{1}{2}$  ounces of Sulpher may bee added thereunto: or take powder 1 l. 2 ounces, and  $\frac{1}{2}$  l. of Salpetre, 4 ounces  
For 3 or 4 z. Rocket, and for Serpents.

and  $\frac{1}{2}$  of coales: or experienced, take powder 1 l, Salpetre 4 ounces, and 1 ounce of coales.  
 For 6 ounces take 2 l. 5 ounces of powder, Salpetre  $\frac{1}{2}$  l, Coales 6 ounces,  
 Sulpher and Limmell of Iron of each 2 ounces.  
For 6 ounces Rockets.

Take for 8 ounces 16 ounces of powder, 4 ounces of Salpetre, and 3 ounces of Sulpher, with 1 ounce of Coale.  
For 8 ounces Rockets or 10 Rockets.

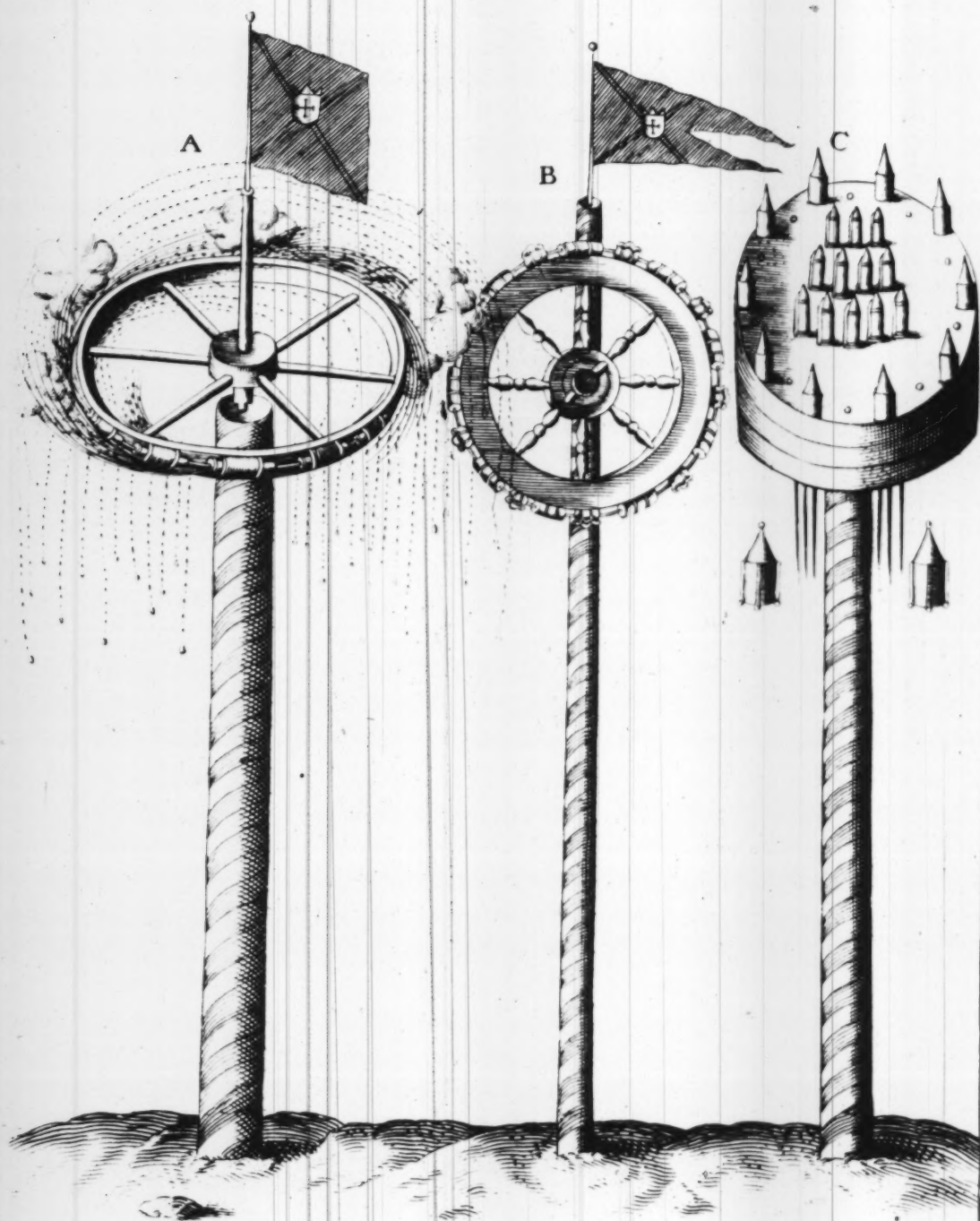
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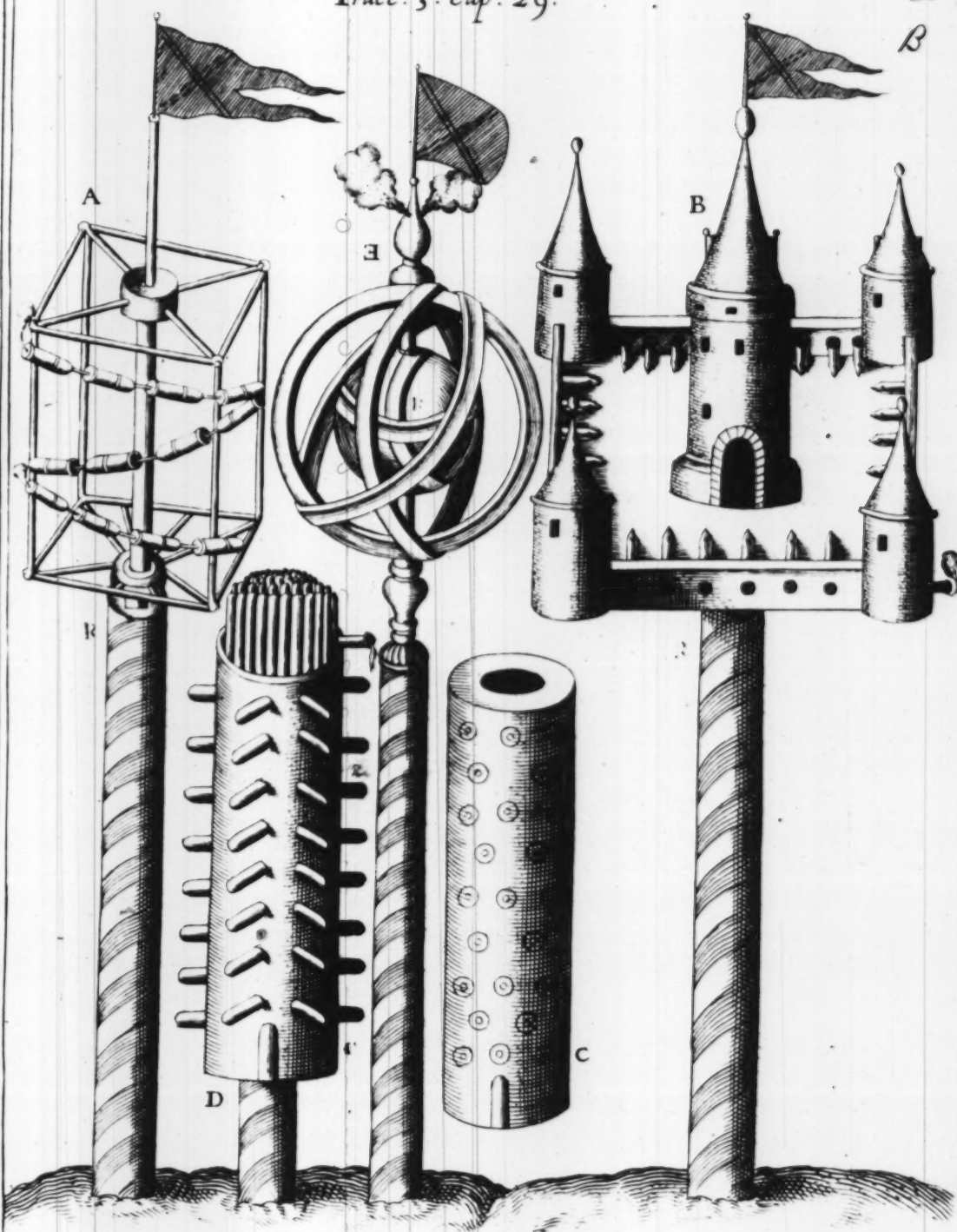
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- For 1 l. Rockets.* Take 2 pound of powder, 5 ounces of Salpetre, 5 ounces of Coales, Sulpher and scales of Iron of each 3 ounces : Or take 1 pound of powder, 3 ounces of Coales, and 1 ounce of Sulpher.
- For 2 l. Rockets.* Take salpetre 12 ounces, powder 20 ounces soft, wood Coales 3 ounces, Scales of yron 2 ounces, and Sulpher 1 ounce.
- For 3 l. Rockets.* Take Salpetre 30 ounces, Coales 11 ounces, Sulpher 7 ounces  $\frac{1}{2}$ .  
Take 30 l. of Salpetre, 10 l. of Coales, 4 l.  $\frac{1}{2}$  of Sulpher.
- For 4, 5, 6, or 7 l. Rockets.* Take 8 l. of Salpetre, 2 l. of Coales and 12 ounces, Sulpher 1 l.  $\frac{1}{2}$ .  
For in the great Rockets you must put no powder, for the reasons aforementioned, as also for that powder having bin long time mealed and dry, it fortifieth it selfe, and groweth too violent. But if you will at euery third or 4 diuining, dip the end of your Drift in oyle, of Petre or Linseed oyle boyled to the height to scald a feather, you may keepe such Rockets long good. The great Rockets are to bee made of the weaker or slower Receipts. And the simples must be well beaten and sifted in a Searce, and well wrought together to incorporate.
- For Breaks.* After the Rocket is filled within two fingerts breadth of the top, you may fold 5 or 6 double paper, and pierce it through, and make a Pettard or Breaker therein of an empty Walnut shell or 2 filld with powder, or a coffined Cap rather of tinned yron Plate, which will giue the better report, & pierce the Ayre swifter, in which you may also put in 2 or 3 Starre made of Cotton bumbast, put in Aqua-vitæ wherein Camphere hath beene dissolued, and sprinkled ouer with Sulphur Viue.
- For Flyers.* The Rocket being thus made, you must binde vnto it a Rod that must equibalance it, if it be placed vpon your Thumb 2 or 3 dyameters from the Rocket, and it should be 6, 7, or 8 times the length of the Rocket, and straight, to cond the Rocket as right through the Ayre as may be : And euer remember to proue some of your Rockets before you goe to performe any shew, and also at the first making that if the Receipt be too strong or too quick, it may be in time slowed with Oyle or Coale : if too slow, with powder or Petre, quickned according to the rising, burning, and arch it maketh.
- For Runners.* Those Rockets that runne on lynes also, ought to be very carefully made, whether they are to double, or single, or those that carie Draggons, Men, Shipps, or other shapes in Motion, least they shame their Master. The lyne must therefore be fine, euen, and strong, and being annoynted with soft Sope, it will be slippery, and not easily take fire. And these as well as those that turne wheelles, may haue a further addition of Roch Petre in their receipt, to adde pleasure and life to the Aspect, which let suffice for Rockets.













## CHAP. LXXIIII.

*The Description of certaine Wheelles of Artificiall Fire-  
workes, and of their Structures and  
Compositions.*

Having already spoken of Rockets sufficiently, we will next speake of Fire-Wheelles, which were wont to be the chiefe inuentions vsed at Feasts and Tryumphes for pleasure, and which by their Motions yeeld great contentment to the spectators, as they were anciently vsed. But now of late by ioynning many Tyres betweene the Rockets that burne, and are moued with variety, the pleasure is much encreased. The Workes may be framed both for verticall, and also for Horizontall Mouers, either vpon great woollen spinning Wheelles, Coach Wheelles, or other Wheelles, made of purpose easie to runne round, and the greater the better shew, and must haue the Perch or Axis whereon they are to turne, fitted vnto the bore of the Naue, which Perch and Wheele should bee annoynted or reuested with some incombustible oyle, oymntment, or coating, to guard it from firing, which would confound the aspect intended in the 2 figure following: the first at *A* is to moue Horizontallly vpon his Perch. The second wheele *B* moueth vertically vpon an Axis, proceeding out of the side of his Perch, their other Structures and Compositions may bee both alike, or varied at the Worke-Masters pleasure, onely that if the Axis of the second were of yron polisht, and fitted to the Naue, it would be surer from breaking and burning, either of which chances would much disgrace the Fire-Master. To Arme them, furnish them with as many Rockets fast bound, and betweene them as many Tyres of coloured Fires, Serpents, breakers, or shewers of Gold, as you shal think with time between them fitted, that the Wheele may moue from the ending of euery Rocket, vntill the beginning of the next, with a Sulpher Match betweene them. And when you haue done so, cover them ouer with paynted papers, although they be represented naked for the Readers better apprehension. Now to make a Wheele or Vessell that shall moue Horizontallly, and haue standing Fire-Lanterns mooue round, and flying Rockets mount vp into the Ayre. The formes of the Lantern, and all the rest may well be conceiued by the same figures at *C*, which for the in-workes, may be also couered with painted paper, as well to hide as grace the Aspect by day-light, before it come to be fired.

## CHAP. LXXV.

*How to make a Rice, and a Castle, and a Trunke of  
Artificiall Fire-workes, of  
great delight.*



He frame *A* is like vnto *Ryces* that skaynes of silke are vsuall wound, and is a pleasing inuention, being inuironed with Bandrolls of Rockets, with a continued ranke: But yet the halfe of them being turned with their heads the contrary way, when the other halfe haue spent themselues: Then by a secret Match on purpose they are fired, and sodainly the motion will be made contrary to the former, the last of the first halfe being spent, it giuing Fire to the first of the latter halfe, which immediarly worketh its effect.

The Frame *B* is a Castle with 4 Towers and 4 Curtins, and a *Canalaria* or domineering Turret in the midst: The structure thereof is with a thicke planke or two, ioyned well together of the bignesse of the plane or foundation of the bottome of the Castle, making a great hole in the midst into, with the top of the Perch, which beareth all the Frame is to enter. The Towers are to be turned of good and strong Timber, about which a number of auger holes, and gutters, are to be made to put to Breakers and Pettards, and to carie Traynes betweene, to fire the Worke in order, in the midst of each Tower a slowe Match is first fired aloft, or an earthen pype fild with sure and slowe receipt, one Tower receiuing fire from another vntill all bee spent. The Curtins also giuing seuerall rounds of Cane Cannons, which being well Armed and loaded, will yeeld a good report: there may be placed *Runners* that shall fire each other, and passe from Tower to Tower, and Flyers, whose Rods may be let downe through the Plankes, the Roofes of the Towers shall haue Turrets arched, and Vanes vpon them, with flagge and flagge-staffe.

The figures *C* and *D* is formed as Cilinder *Granado* made of turned Timber, as bigge as you will with a hollow Concaue Cillinder in the midst from end to end: That a Match or slowe receipt may orderly fire the Rockets and Cannons entered into the hole. And if you would issue a quantity of Flyers aloft, at once to spread and flye every way, place them declining somewhat that way you would haue each flye when fire shall be giuen: So shall you with a small care and handinesse giue great variety of content to the spectators to your commendations.





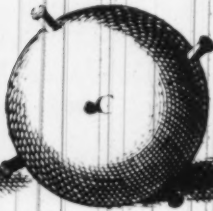
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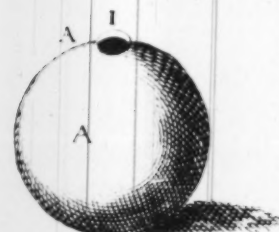
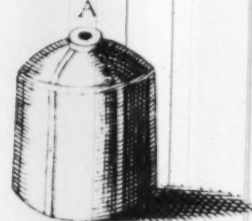
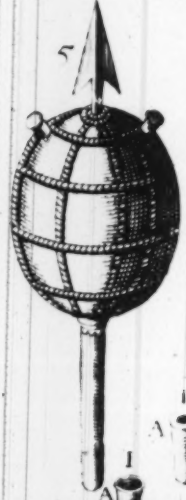
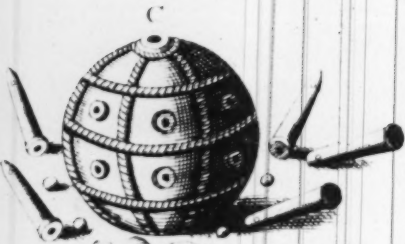
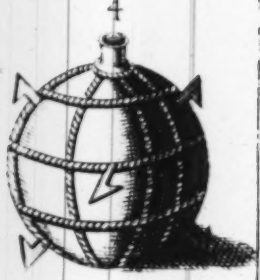
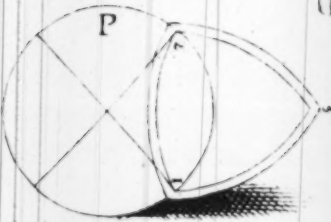
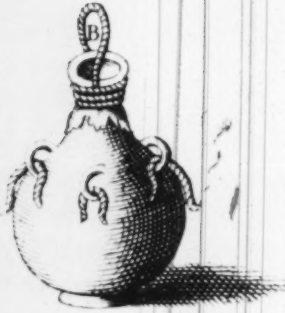
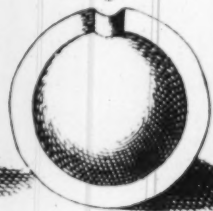
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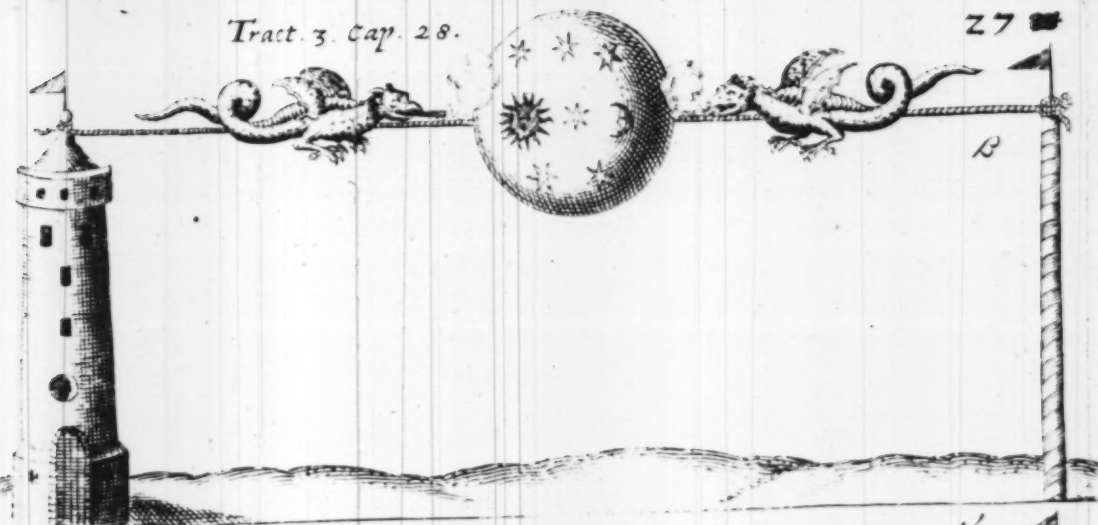
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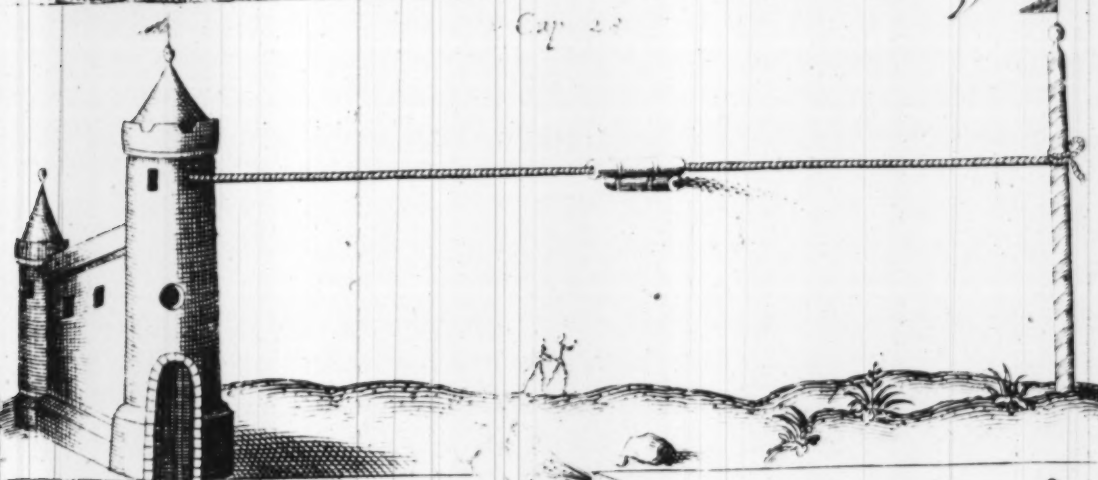
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Cap. 29

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Tract. 3. Cap. 30.

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CHAP. LXXVII.

*How to make flying Dragons and Rockets that will runne vpon  
a Lyne and returne againe, and of Nocturnall  
Combates in Fire-workes.*



He burning flying Draggon is somewhat busie in the contri-  
uing Structure and Compositions thereof, and he must be his  
Arts-Master that can performe the same well: Although per-  
fection be not required therein, we will shew the easiest man-  
ner of Framing and Arming them, and putting them in pra-  
ctise, furnishing each of them with one or two Mayne Rocket of a pound or  
two of Receipt for that grandure as afore-said, according to the way and  
waight thereof, which must passethrough the bore threof, hauing a sparkling  
starry flaming Receipt to burne in the Draggons mouth, that being fired  
when the vent at the Tayle is fired may make the Draggon seeme to breath  
Fire forwards, and voyde Fire backwards also: The body thereof being all  
ouer furnished with ordetly Tyres of Breakers that at last shall breake and  
consume all the body thereof, which being framed with Ribs of dry light  
wood, or Whale bone or Crooked Lane Plates, and couered either with  
Paper or Muscouie Glasse, coloured like to a Draggon, may so represent  
that creature in shape: these are to haue either a voyde Cane, or else cer-  
taineswiules for a lyne, freely to enter into that ballasted, it may almost  
equipoyzedlyhang, and be yare to runne vpon a lyne. Now at great Try-  
umphes two of these Draggons may bee made to moue oppositely vnto the  
midst of the lyne, whereas a Globe with Sunne, Moone, Starres, & Clouds,  
may appeare liuely represented, as in the 24 Figure at y is shewed. The line  
may be made either of Iron or Brasse Wyre, or of Whipcord, annoynted  
with Sope, or such like incombustible matter. These Draggons and Globes  
may be framed with Arches and Circles of thinn Latten, fastned with small  
lynnes, vntill the Body thereof bee framed to your minde. And then set vp  
her wings as she were flying, somewhat shaking with small Rackets in them.  
Also in the same Figure is a double Rocket, coyned with a vacant Cane,  
they are placed ones head to the others vent, to the end that when the first  
hath caried the other to the end of the lyne, the other may take fire, and re-  
turne to the place where it first began his Motion. Also it will be a pleasant  
spectacle to behold to see two men issue forth at contry places, armed with  
small Trunks or Staues, and Targets furnished with Artificiall Fireworkes,  
which putting themselues amongst the People, shall Combat together in  
Fire. The Targets being of Plankes, may spyrally haue Fires of Breakers  
and Rockets: And the Trunkes and Staues furnished with Cane Armed,  
Rockets & Pettards, no bigger then a quill, and Armed loaded Nutshell: Or  
in stead of Staues or Trunkes, they may haue woodden dulled Swords or  
Curtlaces, furnished with Fireworkes, which will be a pleasant fight.

## CHAP. LXXVIII.

*How Artificiall Fireballs and Granadoes are to be formed and loaded with their mixtures.*



*Fireballs* and *Granadoes*, are vpon all occasions very offensive to the Enemy, to vex and trouble them in their Armie, or besieged in their Hods, or Houses, Tents, or Trenches, Bulwarkes, and Defences. They may be made round many wayes, according to their Calibre resolved. First, take strong Canuas, and cut out 2 Circles; greater, or more in dyametre then the Calibre, and hauing turned in the edges of their Peripheries, sowe them strongly with Needle and Thrid round about, onely leauing a little hole, vntill you haue thereby loaded the Receipt, ramming it in very hard, and working it Globally: Or else cutting the Canuas into 8 quarters, as appeareth at *P* in the 27. Figure 2, or into 4 quarters, with the Compasses as Footballs, with crosse quarters: Otherwise some cut them into 12 panes, as the Globes are canted in their couering papers, but by their too many seames they become tedious, and subiect often to open. If you meane to shoote them out of a Mortar or other Peece, you must haue a respect vnto the bore of the Chase, that lopped, and armed, and coated, it may neere fill the Concaue Cillinder. And if you intend to make Balls to sticke, and Fire commonly *Hedgehogges*, you hauing sleight filled your Ball vnto a Marke, must take two crosse shapè barbed poynted, hardned, or Steele Irons, that must be put in to the Ball, to appeare through on each side, as at 4 therein is represented: Or loading it with Cannon Chambers and Shot as at *C*. These may be pryed and fired before they be put in to the Peece. The Figure *A* representeth inuention of a Lanthorne, or case that with a prying Pype, firing a quick Receipt at a time lunted, will breake and blow vp, and teare all neere it fired, yea though it were shot or buried in earth or wall.

The Balls that breake made either of hollow mettall glasse or clay, baked, and nealed, and loaded with quick Receipts and pype, to pryne with slowe receipt for time, are either single or double to breake, are commonly called *Granadoes*. But Fire-pots and Balls to throw out of a mans hand, or with a *Bascula* may be made of Potters Clay baked with *Eares*, vnto which lighted Matches be fastned, and throwing them, to light vpon any hard materiall, when they breake, the Matches lighten the powder, and dispierce the peeces (or Pistoll-shot contriued about them) as at *B* may be scene. Their mixtures may be of Powder, Petre, Sulpher, and Salarmoniack, of each 1 l, and 40 z. of Campher pounded, and serced, and mixed well together with molten Pitch, Linseed oyle, or oyle of Petre, proue it first by burning: if it be too slowe, adde more powder; and if too quicke, more Oyle or Rozen. The Balls & Pypes *A A* and *11*, shew how to make double Balls to light a Champion with one, and when it is thought the force past, it breaketh and teareth all neere it: At *B* and *Z* the making and loadings are represented.

CHAP.

1. The first part of the paper is devoted to a general discussion of the problem.

2. In the second part, we consider the case of a single particle.

3. The third part is devoted to the case of a system of particles.

4. In the fourth part, we consider the case of a continuous medium.

5. The fifth part is devoted to the case of a system of continuous media.

6. In the sixth part, we consider the case of a single continuous medium.

7. The seventh part is devoted to the case of a system of continuous media.

8. In the eighth part, we consider the case of a single continuous medium.

9. The ninth part is devoted to the case of a system of continuous media.

10. In the tenth part, we consider the case of a single continuous medium.

11. The eleventh part is devoted to the case of a system of continuous media.

12. In the twelfth part, we consider the case of a single continuous medium.

13. The thirteenth part is devoted to the case of a system of continuous media.

14. In the fourteenth part, we consider the case of a single continuous medium.

15. The fifteenth part is devoted to the case of a system of continuous media.

16. In the sixteenth part, we consider the case of a single continuous medium.

17. The seventeenth part is devoted to the case of a system of continuous media.

18. In the eighteenth part, we consider the case of a single continuous medium.

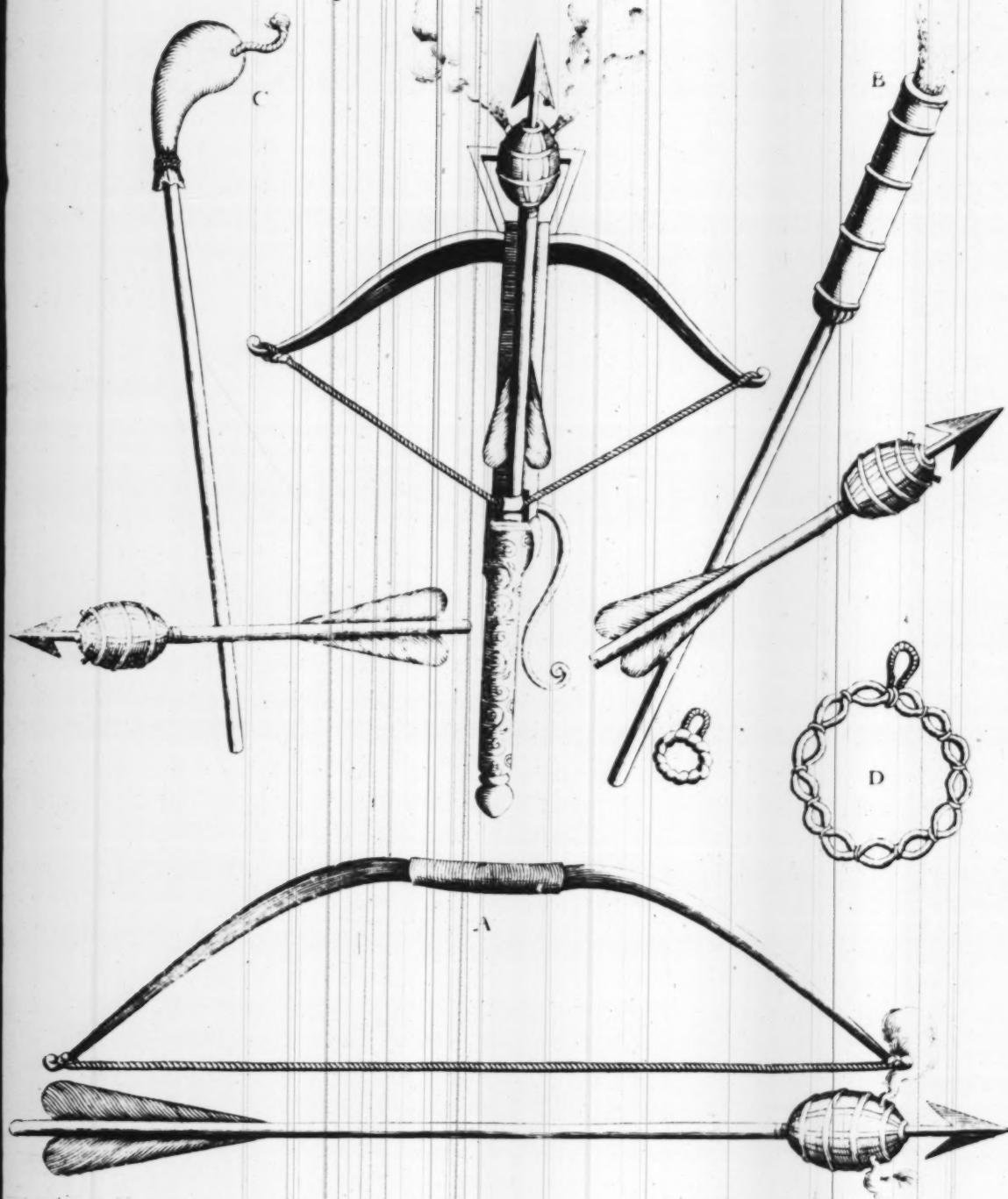
19. The nineteenth part is devoted to the case of a system of continuous media.

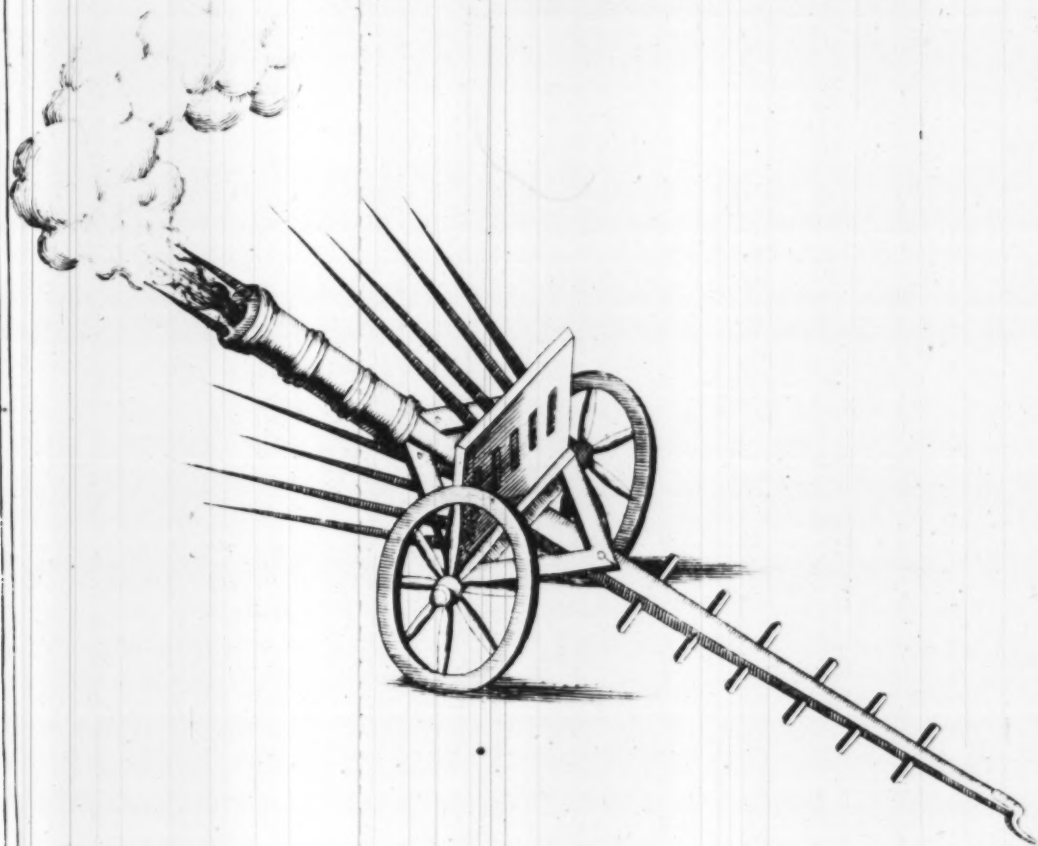
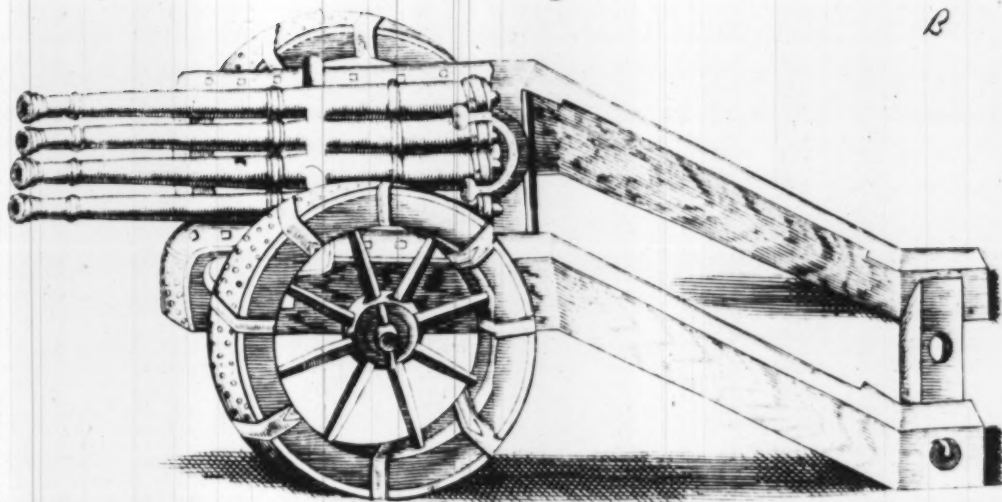
20. In the twentieth part, we consider the case of a single continuous medium.



α

Tract. 3. Cap. 23.









CHAP. LXXIX.

*How to conuoy or direct Fire into a place assigned, or vpon the  
Enemie in an Assault.*



Being desirous to fire any Ship, Barque, House, Barne, or other building combustible, the Crosbowe, the *Slurbowe*, with his Rack or Gasse to bend it, represented in the 25 Figure at *a*, charged with a Fire Arrow fitted therefore, with a Mixture proper thereunto, by the Barbes on the Arrow heads, it will hang where it strikes, and by the vents made of purpose, it will fire whatsoever combustible matter shall bee neere it, especially Sayles, dry Timbers, or Pitch and Tarred places: the effect of this Instrument was well experimented at the Siege of *Ostend* and else-where, taking great effect. The like may be done with a long Bowe, but that the Arrow must be longer, as may appeare at *A*. The Trunke *B* will bee necessary for defence of a Breach, or to keepe a narrow passage, or in giuing an Assault, or entring a Ship to keepe all the Defendants before, or in the night sodainly to set vpon Foote or Horse, or in an *Onslaught*. To the same effect is the Pocket or Bagge *C* filled with fitting Mixtures, whereof wee spake in the last Chapter for resisting the Enemie, assaulting, by sensing or displaying it about on all sides. The Garland *D* being filled and coated with one of the said Mixtures, will do much damage vnto whatsoever it lights vpon being combustible. The Arrowes, Darts, and Bagges are to be prymed by Vents, and Armed with Marling, and coated with the Roch fire before mentioned.

But if the *Enemie* be approached to the foote of the wall, and yet couert, in that case, vse the Instrument traced at *T* and *S* in the 27 Figure *a*, which is a block of square or round Timber, pearced and loaded with quick Powder, and on the sides round about it hauing holes bored to the Concaue, either to receiue Pistoll-shot or 3 square Irons poynted, that being let downe by 2 Ropes from the top of the Wall or Parapet, may by a Snap-hance or Match drawne through a Trayne or Channell of dry powder, Fire the loading within, which by the bores will giue direction to the Shot, to doe the *Enemies* mischiefe, when other deuises cannot be vsed to repulse them.

CHAP. LXXX.

*Of the Pyked Trunke Gunne, and quadruple  
Barrell-Peeces.*



Hese latter Peeces represented in the 25 figure at *b*, are to be accounted amongst the number of *Bastard* Peeces, but are of a new and seruiceable inuention, not only for their lightnes, but also for the great slaughter of the *Enemie* they will make being duly vsed.

The first of them is 4, 5, or 6 Peeces ioyned together, lying like Organ-Pypes placed vpon a broad Cariage, taking fire all at once by meanes of a Gutter or Pype, that conuayeth the trayne of priming powder, from one touch-hole to the next, and all the rest: these are of the proportion of legitimate Culuerings, being 27 Calibres in length of their Chase, and double fortified, being 1 and a halfe in thicknesse at the Calibre of the Bore in Mettall, each carying 1  $\frac{1}{2}$  of Iron cast shott, with  $\frac{3}{4}$  of powder, or else 1  $\frac{1}{2}$  and a halfe of Lead shott, with as much in waight of fine powder: Or they may be loaded with pease leaden or spelter round shott, which will pierce an Armour of prooffe 12 score yards off at least, being put in a bagge or Cartrouch for each Peece. And some few of these will send to the Enemie a farre off a continuall vley, or shewre of shot, they are neate and light, for foure of them will not much exceede 2000  $\frac{1}{2}$  waight, and to keepe a Passage, or defend a Breach, they are of excellent vse.

The second Peece is a Trunke Gunne for fashion, like a Fowler, but close breeched, and is discharged with any charge: in the Cariage thereof behind there is a thick Elme Planke Musket prooffe, with Loopes to the end: their Conducts may be safely couert from Muskets before them: Their wheelles neede not be grosse, and the shaft is with crosse pinnes. Behind in the midst of the Cariage to drine it forward by mens force, in the midst thereof, is a Barrell, like the figure, filled with inextinguished fire, and loaded with Cane, Chamber, with Musket or Caliuier shott, and fine corne powder, and guarded at the Mouth with two Iron or steeled Pykes, and on each side of the Cariage foure long ones fastned, some few of which will exceedingly gall a troope of Horse Charging, and are easily moued; for 2 men with their Muskets are onely needfull, and for their vse, and the structures of them the figure will sufficiently explaine. for their receipt, it may be any sure one with Roch Petre to flame, and scales of Iron to sparkle which vnto Horse by reason of the continuall casting out of Fire, and Flame, and Musket shott, or smaller, will exceedingly affright and gall Horse-Troope, which let it suffice.

## A Table of Proportions for old Receipts.

For Fire-Pikes 2 Pound weight  
a peece for one dozen.

*Powder* 10 pound.

*Peter Roch* 2 pound and a halfe.

*Peter Meald* 2 lb. and a halfe.

*Sulpher* 1 lb. and a halfe.

*Rosen* 1 lb. and 3 quarters.

*Turpentine* halfe a lb.

*Linsced-Oyle* halfe a lb.

Som. tot. 19 lb. 4 oz.

For Coating and Arming.

*Sulpher* 3 lb.

*Turpentine* a quarter of a lb.

*Threca* 1 lb. and a halfe.

Som. tot. 4 lb. 12 oz.

For 2 dozen of Balles, each one  
lb 3 quarters Dry worke.

*Powder* 24 lb.

*Sulpher* 1 lb. and a halfe.

*Rosen* 1 lb. and a halfe.

*Peter Roch* 3 lb. and a halfe.

*Peter meald* 1 lb. and a halfe.

Som. tot. 32 lb.

For Coating and Arming.

*Pitch* 2 lb. and 3 quarters.

*Rosen* 3 lb.

*Sulpher* 3 lb. 3 quarters.

*Tallow* halfe a lb.

*Marlin* 2 lb. and a quarter.

*Cannas* 3 quarters of a yeard.

Som. tot. 10. lb. and a quarter.

For 2 dozen of Balles wet worke  
of 2 lb. a peece.

*Powder* 24 lb.

*Peter Roch* 8 lb.

*Peter meald* 6 lb.

*Pitch* 1 lb.

*Rosen Roch* 1 lb.

*Turpentine* 4 lb and a quarter.

*Linsced-oyle* halfe a lb.

*Trayne-oyle* halfe a lb.

Som. tot. 45 lb. and a quarter.

For Coating and Arming.

*Pitch* 7 lb.

*Rosen* 1 lb.

*Sulpher* 4 lb.

*Cannas* 1 yeard and a halfe.

*Small Marle* 3 lb.

Som. tot. 15 lb. and a halfe.

For Arrowes 2 dozen each 1 lb.

*Powder* 12 lb.

*Sulpher* 3 quarters of a lb.

*Rosen* 3 quarters of a lb.

*Roch Peter* halfe a lb.

*Peter meald* 3 quarters of a lb.

Som. tot. 15 lb. 3 quarters

For Coating.

*Sulpher* 5 lb.

*Peter Roch* 2 lb.

*Peter meale* 1 lb.

1 Yeard of Cannas  
and Marlynnes. } 1 lb.

Som. tot. 9. lb.

For 1 Dozen of Pots, each one  
lb. and a quarter.

*Corne Powder* 1 lb. and a halfe.

*Ser Powder* 9 lb.

*Sulpher* 3 lb.

*Peter Roch* 1 lb. and a halfe.

Som. tot. 15. lb.

For Capping.

*Cannas* 1 yeard.

*Quins* a quarter of a lb.

*Sulpher* 3 quarters of a lb.

*Packshred* 1 oz.

Som. tot. 1 lb. 9 oz.

For Hoopes.

*Ser Powder* 2 lb.

*Roch Peter* 3 oz.

*Petre meald* 2 oz.

*Rosen* a quarter of a lb.

*Sulpher* a quarter of a lb.

*Turpentine* 1 oz.

*Linsced-oyle* 1 oz.

*Trane-oyle* 1 oz.

For Coating.

*Pitch* 3 quarters of a lb.

*Rosen* a quarter of a lb.

*Sulpher* 1 lb.

*Tallow* 2 oz.





### The Authors Len-voy.

**S**ince now my Booke thou art so farre gone on,  
Abroad on Gods name, and be better knowne :  
But had there begne now but one quarter done,  
That, nor the rest, should ne're haue seene the Sunne:  
To friends be free, ope them, thy Treasures store,  
But carping Scoffers let them haue no more  
But Scraps, for that's enough and good for such  
As poyson all they see, soule all they touch :  
And on Mechanick scapes forge Art's detraction,  
Ere they will winke or mend, which is the faultier Action?  
The Errats made, theyle not, did I intend it  
For such as not commend, nor can come mend it,  
Not I, and so I end it.

